By Charles Tomlinson

Etty Sarney.
The gift of her
Aunty Annie

Ettie A. Jordan
Dec 31st 1884—

STEPPES OF THE CASPIAN SEA.

Page 105.

THE

NATURAL HISTORY

OF

COMMON SALT:

ITS MANUFACTURE, APPEARANCE, USES, AND DANGERS, IN VARIOUS PARTS OF THE WORLD.

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THE

NATURAL HISTORY OF COMMON SALT.

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In the providential arrangements of the world, the absolute necessaries of life are either supplied with unsparing abundance, or may be procured with moderate exertion. Air, light, and water are necessary to our existence, and are supplied

without exertion on our part; salt is a necessary ingredient of our food, and is stored up in immense quantities under various forms. Not only do the waters of the ocean contain common salt as their chief saline ingredient, but in countries far removed from the ocean, vast stores of *rock-salt*, or *sal-gem*, as it is called, are in many places treasured up at a moderate depth beneath the surface of the earth. "Had not the beneficent providence of the Creator laid up these stores of salt within the bowels of the earth, the distance of inland countries from the sea would have rendered this article of prime and daily necessity unattainable to a large portion of mankind; but under the existing dispensation, the presence of mineral salt in strata which are dispersed generally over the interior of our continents and large islands, is a source of health and daily enjoyment to the inhabitants of almost every region of the earth."*

"It hath pleased the Author of nature to provide mankind with ample stores of this most useful and necessary commodity. It is dispersed over all nature; it is treasured up in the bowels of the

* Buckland: Bridgewater Treatise.

earth; it impregnates the ocean; it descends in rains; it fertilizes the soil; it arises in vegetables, and from them is conveyed into animals; so that it may well be esteemed the universal condiment of nature; friendly and beneficent to all creatures endowed with life, whether it be vegetative or animal."*

The abundance of this valuable condiment among ourselves, renders it difficult for us to realize the condition of those people in some parts of the interior of a vast continent like Africa, who, not having the knowledge and skill to search for and procure a supply of salt in their own country, are either deprived of it altogether, or obtain a scanty portion from time to time by a long and costly land carriage. In such a case, salt is far more expensive than the purest white sugar in Europe, and is held in greater esteem even by children. When the mother is engaged in preparing food, the children will stand around her wistfully looking out for a morsel of salt, just as in England little silent gazers are attracted around their mother while making sweetened dishes, in hopes of obtaining a bit of sugar. "In the inte-

* Brownrigg, on the Art of making common Salt. 1748.

rior countries," says Mungo Park, "the greatest of all luxuries is salt. It would appear strange to an European to see a child suck a piece of rock-salt as if it were sugar. This, however, I have frequently seen, although in the inland parts the poorer class of inhabitants are so very rarely indulged with this precious article, that to say a man eats salt with his victuals, is the same as saying he is a rich man. I have myself suffered great inconvenience from the scarcity of this article. The long use of vegetable food creates so painful a longing for salt, that no words can sufficiently describe it."* Another traveller states that among the Abyssinians, good housekeeping consists chiefly in the economical management of their stock of salt; and among other notable modes of making a little do duty for a considerable quantity, besides affording an additional stimulant to the palate, is the system of combining it with pepper. The Abyssinians suffer considerably in their health from the difficulty of obtaining salt.† When Mr. Burchell was exploring the interior of Southern Africa, he and his party occasionally suffered from

* Travels in the Interior of Africa, vol. i. p. 280.

† Johnston: Travels in Abyssinia.

the want of this article. On one occasion he met a caravan of Koras who had a quantity which they had procured from a salt-pond; they consented to exchange about half a gallon for a knife. On another occasion this excellent traveller had to send to a considerable distance for a supply. "Those," he says, "who have never been in want of salt, will scarcely think this small quantity (about a gallon) worth a journey of ninety miles, or that when obtained it should appear to us a valuable and important acquisition."*

The chemical name of common salt is *chloride of sodium,* its two constituents being united in the proportion of 36 parts by weight of chlorine, to 24 of the metal sodium. Chlorine is a gas of a greenish yellow colour (whence its name, from χλωρὸς, green), of a pungent smell, very irritating and injurious when respired. When largely diluted with air, it is very useful as a purifier, destroying as it does all contagious and infectious matter and bad odours. Sodium is the metallic basis of the alkali soda. It is a soft malleable metal, yielding to the pressure of the finger and thumb; it is lighter than water, has a silvery

* Travels in South Africa. 1822–4.

lustre, which becomes instantly tarnished on exposure to the air. If touched with a drop of water, or thrown upon ice, it burns with a whitish yellow flame, and produces soda. If a piece of sodium be heated and plunged into a bottle containing chlorine, the metal burns vividly, unites with the chlorine in the proportion of 24 parts of the metal to 36 of the gas, forming chloride of sodium, or common salt. This is a striking instance of the power of chemical combination to produce from two bodies whose properties are entirely different from each other, and so dangerous that great caution is required in making use of them, a third body whose properties in no way resemble those of its constituents, and instead of being poisonous and dangerous, eminently qualify it to become an indispensable article of food to man and beast.

Common salt may also be formed artificially by adding muriatic acid* to soda. The hydrogen of the acid unites with the oxygen of the soda to form water, and the chlorine of the acid with

* This acid, formerly called *spirit of salt*, is now more properly called *hydrochloric acid*, a name which indicates its chemical composition, namely, hydrogen and chlorine.

the sodium of the soda to form chloride of sodium. From this method of forming common salt, the term *muriate of soda* was formerly applied to it.

But however formed, whether artifically by the chemist, or by the hand of nature, whether obtained from the evaporation of sea-water, or dug out of the bowels of the earth, pure chloride of sodium has everywhere the same properties. It may be fused at a red heat without the separation of its two powerful elements; on being cooled again, it concretes into a hard white mass, but it is still common salt; at a bright red heat it sublimes in the air, and tinges flame of a blue colour, but does not decompose. It is insoluble in pure alcohol, and dissolves in small quantities in the watery portion of proof spirit.* It dissolves in water with this curious peculiarity, that hot water scarcely dissolves a larger portion than cold water; so that crystals are not deposited during the cooling of a solution of salt, as is the case with the solution of most other salts; crystals of salt are therefore only or chiefly obtained during the

* By *proof spirit* is usually meant alcohol diluted with its own bulk of water.

evaporation of the water. According to Gay Lussac, 100 parts of water at 58° dissolve 36 parts of salt; at 140°, 37 parts, and at 225°, which is the boiling point of a saturated solution, 100 parts of water dissolve 40.38 of salt. At 32° water dissolves rather more salt than at 60°. According to Fuchs, pure chloride of sodium is equally soluble at all temperatures, 100 parts of water dissolving 37 of salt. The ice which forms at low temperatures in salt water is itself free from salt, a property taken advantage of in some cold countries in the manufacture of salt, as will be noticed hereafter.

Pure salt does not alter by exposure to the air, but as it generally contains minute portions of other salts which absorb moisture from the air, common salt is generally more or less deliquescent.* The form of the crystal of common salt is a solid cube, if obtained by slow spontaneous evaporation; but when procured at a boiling heat from the surface of a solution, the crystals are

* Salts, which by exposure to the air lose their transparency and crumble down into a white powder, are said to be *efflorescent*; but those salts which attract moisture from the air, and thus dissolve away, are said to be *deliquescent*.

hollow four-sided pyramids.* The best method of taking an easy lesson in crystallization is that described by Professor Brande: †—Put a tea-spoonful of common salt, nitre, Glauber salt, and Epsom salt, into separate wine-glasses: fill them up with water, and occasionally stir their contents to help the solution: when dissolved, take a drop of the clear liquor with a glass rod out of each of the wine-glasses, and place them side by side upon a strip of clean glass, which may be placed upon a chimney-piece, or somewhere very gently warmed. As the water evaporates the salts will crystallize, and we shall observe the following figures appropriate to each: the common salt exhibits *cubes;* the Epsom salt, *four-sided prisms;* the nitre, *striated six-sided prisms;* the Glauber salt, *six-sided prisms.* These figures will be seen to most advantage through a small microscope.

Salt serves some important and essential uses in the animal economy. Its agreeable taste causes it to be relished by the people of all nations, from the most refined to the most barbarous; but the

* The form and structure of the crystal are described at page 53.

† Manual of Chemistry, vol. i. p. 6.

quantity taken varies in different individuals. It is the only saline condiment essential to health. "The existence of a greater or less appetite for it in all individuals, appears to me to show that this substance must serve some more important uses in the animal economy than that of merely gratifying the palate. In considering these, we observe, in the *first* place, that it is an essential constituent of the blood, which fluid probably owes some of its essential properties to its saline matter. Now, as the blood is constantly losing part of its saline particles by the secretions, the tears, the bile, &c., the daily loss is repaired by the employment of chloride of sodium as a condiment. In the *second* place, the free hydrochloric acid found in the stomach, and which forms an essential constituent of the gastric juice, is obviously derived from the salt taken with our food. *Thirdly*, the soda of the blood and some of the secretions is doubtless obtained from the decomposition in the system, of common salt. These are some (probably only a portion) of the uses which chloride of sodium serves in the animal economy. It deserves especial notice that while salt is thus essential to health, the continued use of salted provisions is injurious. But

their noxious quality is probably to be referred rather to the meat, whose physical and chemical qualities are altered, than to the presence of the salt; though we can readily conceive that an excessive use of salt, or of any other article of food, will be followed by injurious consequences. However relishing salted fish (as anchovies, herrings, cod, &c.) may be, they are difficult of digestion."*

Dr. Stephens has shown that in certain states of disease, as cholera, there is a deficiency of the saline matter in the blood, which led him to prescribe frequent doses of carbonate of soda, chloride of sodium and chlorate of potash for cholera patients. It is said that persons who take little or no salt with their food, are very subject to intestinal worms. Lord Somerville, in his address to the Board of Agriculture, states that the ancient laws of Holland "ordained men to be kept on bread alone, unmixed with salt, as the severest punishment that could be inflicted upon them in their moist climate; the effect was horrible: these wretched criminals are said to have been devoured by worms, engendered in their own stomachs." Mr. Marshall relates the case of a lady who had a

* Pereira: Materia Medica.

natural aversion to salt; she was most dreadfully affected with worms during the whole of her life.

The antiseptic* properties of salt are by no means well understood. It is usual to ascribe them to the drying influence of the salt. "A dry bladder," says Liebig, "remains more or less dry in a saturated solution of common salt. The solution runs off its surface in the same manner that water runs from a plate of glass besmeared with tallow. Fresh flesh over which salt has been strewed is found after twenty-four hours swimming in brine, although not a drop of water has been added. The water has been yielded by the muscular fibre itself, and having dissolved the salt in immediate contact with it, and thereby lost the power of penetrating animal substances, it has on this account separated from the flesh. The water still retained by the flesh contains a proportionally small quantity of salt, having that degree of dilution at which a saline fluid is capable of penetrating animal substances. This property of animal tissues is taken advantage of in domestic economy for the purpose of removing so much water from meat

* Opposed to putrefaction.

that a sufficient quantity is not left to enable it to enter into putrefaction."

Salt, as an article of food, is so important and necessary to the welfare of man, that, in many parts of the sacred writings, we find this mineral used in holy ceremonies. Its use was solemnly enjoined by the Levitical law:—"Every oblation of thy meat offering shalt thou season with salt; neither shalt thou suffer the salt of the covenant of thy God to be lacking from thy meat offering: with all thine offerings thou shalt offer salt." (Lev. ii. 13.) According to some of the rabbinical commentators, the salt used in the sacrifice implied that purity of mind and sincerity of feeling necessary in all worshippers who desired to offer an acceptable sacrifice to Jehovah. Others assert, that the salt was an emblem of the fidelity and incorruption of the covenant which God had established with his chosen people. Our Saviour alludes to this custom in Mark ix. 49:—"Every one shall be salted with fire, and every sacrifice shall be salted with salt."

The salt used in the temple was rock-salt; and considerable quantities were stored up in the temple for use. The rock-salt, in its natural state,

was mingled with clay or sand, and, being exposed to the air, some of the salt absorbed moisture, and thus wasted away. The salt being thus deprived of its savour, was scattered over the pavement, to render it less slippery in wet weather, or it was thrown out to mend the roads. Our Saviour alludes to this when he says to his disciples—"Ye are the salt of the earth: but if the salt have lost his savour, wherewith shall it be salted? it is thenceforth good for nothing, but to be cast out, and to be trodden under foot of men." (Matt. v. 13.)

Maundrell, in his narrative of a journey to the Euphrates, says, that in the Valley of Salt, about four hours' journey from Aleppo, there is a small precipice occasioned by the continual taking away of the salt. "I broke a piece of it off, of which the part exposed to the sun and rain and air, though it had the sparkling of salt, yet it had perfectly lost its savour: the innermost part, which had been connected with the rock, retained its savour, as I found by proof."

Valpy, in a note on the passage in Matthew just quoted, says, "Livy calls Greece *Sal gentium*, or the 'salt of all the nations;' on account of the in-

tellectual improvements they learned from thence. In the same sense, our Saviour tells the disciples, and, indeed, all Christians, 'Ye are, or are to be, the salt of the earth'—the means of preventing or curing the growth of that corruption which prevails in it, and of seasoning men's minds with wisdom and grace."

Federal engagements among eastern nations were usually ratified by salt. The Bedouin robber will not violate the laws of hospitality to a guest who has once tasted of his salt; the guest is also bound by reciprocal obligations. The following is a practical illustration of the strength of this bond:—"Yaakoob, the son of Eb-Leys Es-Suffar, having adopted a predatory life, excavated a passage one night into the palace of Dirhem, the governor of Seestan; and after he had made up a convenient bale of gold and jewels, and the most costly stuffs, was proceeding to carry it off, when he happened, in the dark, to strike his foot against something hard on the floor. Thinking it might be a jewel of some sort or other, he picked it up, and put it to his tongue; and, to his equal mortification and astonishment, found it to be a piece of rock-salt; for, having thus tasted the salt

of the owner, his avarice gave way to his respect for the laws of hospitality, and, throwing down his precious booty, he left it behind him, and withdrew, empty-handed, to his habitation. The treasurer of Dirhem repairing on the next day, according to custom, to inspect his charge, was equally surprised and alarmed at observing that a great part of the treasure had been removed; but on examining the packages that lay on the floor, his astonishment was not less to find that not a single article had been conveyed away. The singularity of the circumstance induced him to report it immediately to his master; and the latter causing it to be proclaimed through the city, that the author of this proceeding had his free pardon, further announced that on repairing to the palace, he would be distinguished by the most encouraging marks of favour." It is further stated that Yaakoob availed himself of this invitation, relying upon the promise, which was fulfilled to him, and from this period he gradually rose in power, until he became the founder of a dynasty."*

A "covenant of salt" is mentioned in the sacred writings. Thus, in Numb. xviii. 19—"All the

* Price: Mahommedan History.

heave-offerings of the holy things, which the children of Israel offer unto the Lord, have I given thee, and thy sons and thy daughters with thee, by a statute for ever: it is a covenant of salt for ever before the Lord unto thee and thy seed with thee." And again, "Ought ye not to know that the Lord God of Israel gave the kingdom over Israel to David for ever, even to him and to his sons by a covenant of salt?" (2 Chron. xiii. 5.) Some commentators explain this covenant by asserting that salt is an emblem of perpetuity, especially as there is in the East a kind of salt so hard as to be used for money;* but others suppose that the covenant of salt refers to an agreement in which salt is used as a token of confirmation. Baron du Tott gives an example of this. He says:—"Moldovanji Pacha was desirous of an acquaintance with me, and seeming to regret that his business would not permit him to stay long, he departed, promising in a short time to return. I had already attended him half-way down stairs, when, stopping and turning briskly to one of my domestics who followed me, 'Bring me directly,' said he, 'some bread and salt.' I was not less

* See page 135.

surprised at this fancy than at the haste which was made to obey him. What he requested was brought; when, taking a little salt between his fingers, and putting it with a mysterious air upon a piece of bread, he ate it with a devout gravity, assuring me that I might now rely on him. I soon procured an explanation of this significant ceremony; but this same man, when he became vizier, was tempted to violate the oath taken in my favour. Yet, if this solemn contract be not always religiously observed, it serves at least to moderate the spirit of vengeance so natural to the Turks." The Baron adds in a note, "The Turks think it the blackest ingratitude to forget the man from whom they have received food, which is signified by the bread and salt in this ceremony."

Calmet states that salt is also the symbol of fidelity due from servants and officers to those who maintain them. Thus, the governors of the provinces beyond the Euphrates writing to the King Artaxerxes tell him, "Because we have maintenance from the king's palace," &c. (Ezra iv. 14,) which in the Chaldee is, "Because we are salted with the salt of the palace," &c.

There are many other interesting passages in

Scripture connected with salt. The prophet Elisha being desired to sweeten the waters of the fountain of Jericho, required a new vessel to be brought to him, and salt therein. (2 Kings ii. 20.) He threw this salt into the spring and said (ver. 21), "Thus saith the Lord, I have healed these waters; there shall not be from thence any more death or barren land."

The "Valley of Salt" is placed by some writers to the south of the Dead Sea towards Idumea, because it is said (2 Sam. viii. 13) that David smote the Syrians in the Valley of Salt, and also that Abishai (1 Chron. xviii. 12) "slew of the Edomites in the Valley of Salt eighteen thousand." See also the title to Psalm lx.; 2 Kings xiv. 7; 2 Chron. xxv. 11.

Salt is also the symbol of barrenness and sterility. When Abimelech took the city of Shechem he destroyed it, and sowed the place with salt, that it might always remain a desert. (Judges ix. 45.) Zephaniah (ii. 9) threatens the Moabites and the Ammonites from the Lord, "Surely Moab shall be as Sodom, and the children of Ammon as Gomorrah, even the breeding of nettles, and salt-pits, and a perpetual desolation." In the description

of the wild ass in Job xxxix. 6, or xxxix. 9, of Wemyss's translation, the barren land, or salt land, or soil is equivalent to a desert.

> "I gave him the desert for a habitation,
> The salt soil for a place of encampment.
> He scorneth the tumult of the city,
> He heareth not the clamour of the driver;
> He traverseth the mountain as his pasturage,
> He hunteth after every green shoot."

Although salt in moderate quantities is useful as a fertilizer, yet, in those places where it forms the chief ingredient in the soil, a sterile desert is the result. There is a striking example of this in those immense treeless plains of America called the *Pampas*, which extend from 22° S. lat. to the most southern limits of the American continent, and terminate on the straits of Magelhaens, near 52° S. lat., thus occupying from north to south a length of 2,000 miles, and varying from 240 to 450 miles in breadth. The salt occurs in an immense plain, known by the name of *Las Salinas*, or the Salt Desert. It is situated in the northern portion of the Pampas, and extends about 200 miles from east to west, and 140 miles from north to south, so that it occupies an area about equal to that of Ireland. The only traveller

who has described this desert, is Mr. French. He says—"The morning was ushered in by a cloudy mist, through which the red sun gradually rose, partially dispersing the upper vapours, while others appeared to resist his influence, and attracted to the earth, remained dense and motionless near its surface. As we entered the Salinas, the scene became novel and striking. The wide plain, level and smooth as a floor, and snow-white with superficial salt, stretched its treeless and shrubless waste on all sides to the horizon, unbroken by any object, save a few stunted, straggling, and leafless alkaline bushes, the black and crooked branches of which, contrasting with the whiteness of the soil, were here and there hid, and intersected by a broad, compact and very thin stratum of mist, whose under surface was slightly elevated from the soil, while its upper was below the tops of the bushes, thus permitting only their stems and tops to be recognised. This was the *mirage*. Over head rolled thick and black masses of transparent white vapour, which, except at intervals, hid the sun without greatly intercepting his light; and when his rays shot between these masses, they were reflected from the space on which they

fell by the saline surface of the soil, with a dazzling effulgence. Such was the appearance of the vast salt plains, at the time we crossed them, in the middle of April. Great changes, however, are produced by a variation of circumstances. I have, myself, observed the most astounding change in the appearance of a portion of the plain, after sudden rain, succeeded by a hot sun. In a region where a slight saline efflorescence is ordinarily seen, the ground became almost snow-white from the rapid crystallization of saline matter, and reflecting the rays of a fierce sun, rendered it most difficult to keep the sight fixed on the road-track. The landscape appeared one blaze of reflected light; trees and shrubs seemed on fire, and the whole scene might have been taken for the land of the genii; while the hot north wind, called the *sonda*, rose by degrees, and in squalls to a gale, with a close heat, like that of a furnace. In this instance nothing in the shape of a cloud or mist was present." On approaching the Andes Mr. French found the plain partly overgrown with wood: but the most remarkable feature of this region is the great scarcity of water and the total absence of grasses. All these countries, which are

distinguished by the name of *traversias,* have a very dry air, and are characterised by great aridness. In some parts of them, rain has not fallen for eighteen months. Dews are entirely unknown. The slight humidity afforded by the general state of the atmosphere, appears to be drawn off towards the Salinas, and absorbed by its saline soil, which thus exhausts the atmospheric moisture so as to render unproductive a soil otherwise favourable for the growth of grass. The Salinas are almost the only places in which, under ordinary circumstances, any moisture is apparent, and in these vegetation becomes extinguished by the excess of salt, with the exception of a few scattered saline and alkaline shrubs. The town of Santiago del Estero, on the banks of the Rio Dolce, in the vicinity of the Salinas, is frequently exposed to great heat, from the hot wind which blows from the salt district. It blisters the skin on the face and hands, even of those who remain indoors. Leaves fall scorched from the trees, and the bark of several of them becomes cracked and shrivelled, just as if the heat of a fire had been applied. Even at night the locks, bolts, and keys of apartments, are too hot to be retained in the

hand. The description given by the inhabitants of their sufferings and feelings under the dread of suffocation is quite appalling.*

Such are the effects of an excess of salt over a large district. In places where salt is not naturally formed, it has been used in agriculture from a very early period. Cato, 150 years B.C. commends salt for cattle, hay, straw, &c., as does Virgil in his *Georgics*. The early German farmers knew its value for sheep; and it has been employed by the Spanish shepherds from the earliest ages. In 1570, Conrad Heresbach commends it as being a certain prevention of the "murrain or rotte." In 1653, Sir Hugh Platt speaks of salt as a fertilizer. During several successive reigns, however, the duty on salt rendered it impossible for the English farmer to become practically acquainted with its value in agricultural operations. The duty originated as a war-tax in the ninth year of the reign of William III. and was not removed until the year 1823. The price of salt in consequence of the duty, was raised from 6*d*. a bushel to more than 20*s*. Salt, as a manure, was therefore known

* Wittich's Curiosities of Physical Geography.

only in the traditions of the English farmers. "Through these they learned that it was formerly used to kill worms and to destroy weeds; that it cleansed fallows, increased the produce of light arable soils, and was good to sweeten grass. These reported advantages were rendered more probable by certain facts that had been forced as it were upon their attention. The gardener was well aware that the brine of the pickling tubs when poured over his heaps of weeds, not only killed every weed, every seed, and every grub, but that these heaps were then converted into so many parcels of the most fertilizing manure; the good effects of which, especially upon potatoes and carrots, were very decided. It was well known too, that a single grain of salt placed upon an earth-worm speedily destroyed it; that if brine were poured upon the lawn, all the earth-worms were immediately ejected from that spot; and that if it were sprinkled about over a portion of the grass, to this salted portion all the deer, sheep, or the horses of the park constantly repaired in preference to any other part of the field."*

The value of salt in agricultural operations will

* Johnson: Farmer's Cyclopædia.

be noticed more fully in a subsequent chapter; but it may here be stated, that like many other substances, it has suffered in general estimation by the unqualified terms in which its merits have been occasionally extolled. More than a century ago, Dr. Brownrigg maintained that the whole kingdom might be enriched by the application of common salt to the soil, and since his time, its use has been at intervals recommended in terms of almost equal praise. But these recommendations have led sanguine men to make large trials of salt on their lands, which have occasionally ended in disappointment; and hence, the use of salt has repeatedly fallen into undeserved neglect.

Common salt may be detected in nearly all soils; it is found in the ashes of all plants, but especially in the ashes of marine plants; and is sometimes borne with the spray of the sea to great distances inland, when the winds are strong and the waves high and broken. On some rocky shores, the spray may be seen occasionally moving up the little coves and inlets in the form of a distinct mist driving before the wind; and the saline matter has been known to traverse nearly half the breadth of our island, before it has been

entirely deposited from the air. It is impossible to calculate how much of the saline matter of sea-water may in this way be spread over the surface of a sea-girt land like ours. It is certain, however, that places nearer the sea will receive a greater portion than those inland, and that those coasts on which sea-winds prevail, will have a larger supply of salt than those in which land-winds are more common.

In those cases in which the use of common salt has failed to benefit the land in particular localities, it must be evident that the soil in these places already contained a natural supply of this compound, large enough to meet the wants of the crops which grew upon it. The facts above stated as to the influence of the wind in top-dressing the exposed coast-line of a country with a solution of salt, may serve as an important guide, both in reference to the places in which it may be expected to benefit the land, and the causes of its failing to do so in particular districts.*

Some curious superstitions connected with salt have been observed in some parts of Great Britain. Among the common people in Scotland a new

* Johnston: Lectures on Agricultural Chemistry.

house, or one which a new tenant was about to enter, was always sprinkled with salt by way of inducing *luck*. A plate of salt was regularly deposited on the breast of a corpse after it was laid out—a custom which was probably intended to have the effect of a charm in warding off evil influences. According to Moresin, salt not being liable to putrefaction, and preserving things seasoned with it from decay, it was the emblem of eternity and immortality. "In reference to this symbolical explanation," says Mr. Brand, "how beautiful is that expression applied to the righteous, 'Ye are the salt of the earth.'" Dr. Campbell, also, in reference to the custom in Ireland, of placing a plate of salt over the heart of a deceased person, supposes that the salt was considered the emblem of the incorruptible part, the body itself being the type of corruption. Mr. Pennant states, that on the death of a Highlander, the friends placed on the breast of the deceased, a wooden platter, containing a small quantity of salt and earth, separate and unmixed; the earth an emblem of the corruptible body—the salt an emblem of the immortal spirit. Herrick expresses the same idea in these lines:—

> "The body's salt the soul is, which, when gone,
> The flesh soone sucks in putrefaction."

Another custom with reference to salt, formerly prevailed in our own, and probably also in other countries. Men of rank and country gentlemen were accustomed to dine at the same table with their dependents and servants. The master of the house and his immediate relations, sat at the upper end, at the orsille or high table, which was a little elevated above the floor. The persons of greatest consequence sat next, and all along, down the sides towards the bottom, the rank of the guests declined by well considered gradations, the servants being found at the bottom. At a certain part of the table was placed a huge salt-cellar, which formed a boundary line between the superiors and the inferiors. Sitting above the salt was the mark of a gentleman, or of a man of good connexions; while, to sit beneath it indicated a humble station in society. This distinction also extended to the fare; the wine frequently circulating only above the salt-cellar, and the dishes below it being of a coarser kind than those near the head of the table.

INTERIOR OF SALT MINE, CHESHIRE.

CHAPTER II.

SUPPLY OF SALT IN GREAT BRITAIN—THE CHESHIRE SPRINGS AND MINES OF SALT—POSITION OF—HISTORICAL NOTICE OF—METHOD OF WORKING THE SALT MINES—DESCRIPTION OF A VISIT TO MARSTON PIT—METHODS OF WORKING THE BRINE—BOILING THE BRINE—DESCRIPTION OF THE CRYSTAL OF SALT—COMMERCIAL VARIETIES OF SALT—STOVED OR LUMP SALT—COMMON SALT—LARGE GRAINED FLAKY AND LARGE GRAINED OR FISHERY SALT—SUNDAY SALT—PAN SCRATCH OR SCALE—ENGLISH COMPARED WITH FOREIGN SALT—METHOD OF COLLECTING DUTY ON SALT—EXPORTS OF BRITISH SALT.

Great Britain, which is so richly supplied with almost every variety of mineral wealth, is furnished with brine-springs and extensive beds of fossil salt. The principal brine-springs are situated in the county of Cheshire, in the valleys through which the Weaver and the small rivulet the Wheelock have their course. The springs do not appear to be strongly impregnated with salt near the source at the Peckferton Hills, nor until the river approaches Nantwich. It is probable, however, that brine does exist higher up, because, in the neighbourhood of Bickley, a sinking of the

ground took place in the year 1657, and the cavity became filled with brine. Leland relates a similar occurrence. He states, that "about a mile from Combermere Abbey, part of a hill, with trees upon it, suddenly sunk down, and became covered with salt-water; of which the abbot being informed, caused it to be wrought; but the proprietors of the wiches* compounding with him, he left off working." He adds, that "this salt pool still continued in his time, but that no care was taken of it."

A few miles below Bickley, in Baddiley, and one or two adjoining townships, salt springs are met with. *Brinefield* is the name given to several of the enclosures in Baddiley. When the river takes a northerly direction at Audlem, brine is met with on each side of it, and may be found on sinking near its banks all the way from thence to Nantwich. Between these two places is a farm still called *Brinepits Farm*, where salt was formerly

* The Saxon word, *wic* or *wick, wich,* &c. signifies the bend of a river, or of the sea-coast; a bay; a town upon such. *Middlewich* in Cheshire derives its name from being the middlemost of the *wiches,* or salt-towns, in reference to *Northwich* and *Namptwich,* or *Nantwich,* which are nearly equidistant from it in the direction signified by the respective names.

manufactured. Numerous springs occur at Nantwich, where salt is manufactured. Brine is met with at several places in descending the river, but it is very weak, from admixture with fresh water. At Wevenham, brine has been found and was worked as early as the time of Wiliiam the Conqueror; but below this place it does not appear to have been discovered. In the course of the Wheelock, brine is first met with at Lawton; then three or four miles lower at Roughwood; again at Wheelock, and lastly, at Middlewich, where the Wheelock falls into the Dane. No brine has been found in the valley of the Dane between Middlewich and Northwich; but higher up this stream, some of the enclosures are named *Brinefield*, *Brinehill*, &c., whence it is supposed that brine was formerly discovered there.

The brine-springs occur at various depths. At Nantwich, the brine is met with about ten or twelve yards from the surface, and in sinking for fresh water, caution is required to avoid the brine. At Winsford, it is generally necessary to sink from fifty-five to sixty yards before it is met with, and then it is found in great abundance, and it rises to within twelve yards of the surface. At

Northwich it is found at a depth of from thirty to forty yards, and its level is about twenty yards from the surface. At Wilton, Anderton, and Bampton, the brine is found at depths varying from forty to sixty-five yards. The springs along the Wheelock generally occur at greater depths, and are not so copious, some of them being occasionally pumped dry.

It is probable that at a very early period salt was procured from such of the brine-springs as found their way to the surface. We learn from Doomsday Book, that in the time of Edward the Confessor, brine-pits were wrought at all the wiches in Cheshire; but at this period, and several centuries later, the art of making salt seems to have been very imperfectly understood, and the quantity manufactured was inconsiderable. Henry VI. being informed that a new and more productive method of making salt had been invented in the Low Countries, invited John de Sheidame, a gentleman of Zealand, with sixty persons in his company, to come to England to instruct his subjects in the method, promising them protection and encouragement. The result of this invitation is not stated; but it does not

appear to have been successful, for we find the Royal Society, soon after its institution, directing their attention to the improvement of the art of manufacturing white salt, and publishing towards the close of the seventeenth century, several modes of making it; or rather, reports of the methods then in use, than suggestions or improvements. The salt made in England was still considered inferior to foreign salt; and that which was manufactured in Cheshire, was confined to the supply of its own consumption, and that of a few neighbouring counties.

About the commencement of the last century, the attention of the House of Commons was directed to the supposed inferiority of the English manufacture; and they granted a reward to Mr. Lowndes, a Cheshire gentleman, for certain improvements in the manufacture made by him. In 1748, Dr. Brownrigg published a treatise, entitled, "The Art of making Common Salt, as now practised in most parts of the world, with several improvements proposed in that art, for the use of the British Dominions." Some of these improvements were adopted with good effect, and others engrafted thereon. The river Weaver was

also made navigable for vessels of considerable burthen from Northwich and Winsford to Liverpool; whereby the facilities for distributing Cheshire salt became greatly increased, and the manufacture gradually rose into importance; salt was not only distributed over the country from this source, but considerable quantities were exported.

The brine-springs, as we have seen, appear to have been worked from the earliest periods in the history of this country, but the beds of fossil or rock-salt, from which springs originated, were not discovered until the year 1670. These were first found about thirty-four yards from the surface, while searching for coal in Marbury, about a mile to the north of Northwich. The salt was discovered in a bed thirty yards thick, and below it was a stratum of indurated clay. This discovery led to other attempts to find it; and on sinking a shaft any where within half-a-mile of Marbury, it was met with at about the same distance from the surface, if the access to it was not prevented by brine or fresh water.

No other rock-salt was discovered till the year 1779, when, in searching for brine near Lawton,

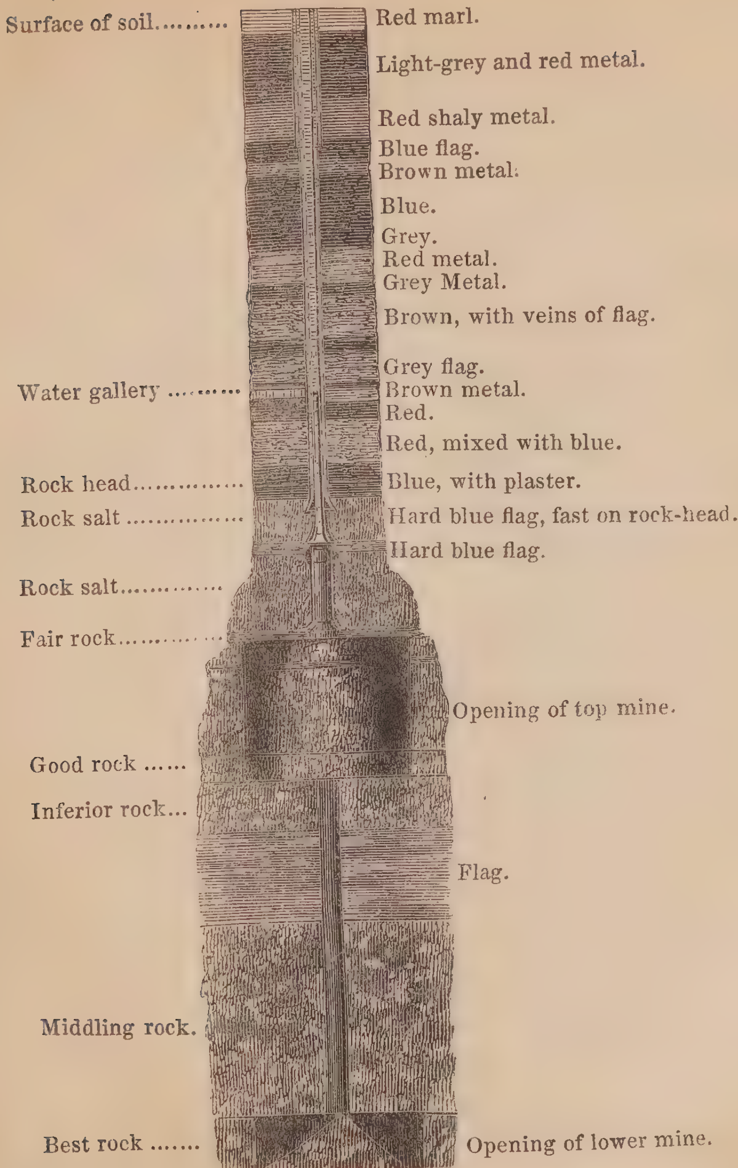
it was met with, about forty-two yards from the surface. This stratum was only four feet in thickness. Below it was a bed of indurated clay, ten yards thick; and in penetrating this, a second stratum of rock-salt, twelve feet in thickness, was found. On continuing the sinking, another stratum of clay, fifteen yards thick, was passed through; and below this was a third stratum of rock-salt, which was sunk into to the depth of twenty-four yards. The lowest fourteen yards, being the purest; these only were worked.

Hitherto no attempts had been made to find a lower stratum of rock-salt in the neighbourhood of Northwich; for as the one first met with was so thick, and furnished an abundant supply, there was no inducement to sink deeper. The fear of meeting with springs at a lower depth, which might impede the working of the pits, prevented the owners from sinking deeper. But as no inconvenience of this kind had been experienced at Lawton, where a much purer salt was found, at a greater depth, than near the surface, the owners of one of the mines near Northwich were led, in 1781, to sink deeper, and to pass through the bed of indurated clay, below the rock-salt which had

been so long worked. This clay was ten or eleven yards in thickness, and immediately below it, was found a second stratum of rock-salt, the upper portion of which differed but little in purity from the higher stratum; but on penetrating into it, from twenty to twenty-five yards, it was found to be much more pure, and free from earthy admixture. This increased purity, however, was observed for only four or five yards; the shaft was sunk fourteen yards still lower, but the proportion of earth was the same as in the upper part of the stratum. It was, therefore, thought useless to proceed further. Several other proprietors of mines in the neighbourhood, also sunk shafts, and obtained similar results.

In sinking for brine or rock-salt, the strata passed through, generally consist of clay, and sulphate of lime, (gypsum,) mixed in various proportions; that of the latter somewhat increasing as the shaft approaches the brine or rock. The workmen* call the clay *red*, *brown*, or *blue metal*, according to its colour; and the sulphate of lime,

* The workmen are called *wallers,* from the circumstance of their raising a bank or a *walling* round the pit with the rubbish of the works.



SECTION OF THE WHARTON SALT MINE, ON THE RIVER WEAVER, CHESHIRE.

they name *plaister*. The strata are in general close and compact, allowing very little fresh water to pass through them. In some places, however, they are broken and porous, and admit so much fresh water into the shaft, that whenever this *shaggy metal*, as the workmen call it, has been met with, it has been usual to discontinue any attempts to pass through it. The steam-engine, however, has been since applied to pump out the water, and the workmen have succeeded in sinking shafts through this porous stratum, through the marl and clay below it, and so into the beds of rock-salt.

On making a horizontal section of the bed of rock-salt, various figures may be observed, differing in form and size, some of them being nearly circular, others more nearly oval, and a third set form an irregular pentagon. Some are not more than two or three feet in diameter, others are ten or twelve feet. The lines which form the boundaries of these figures are white, and from two to six inches wide, and consist of pure rock-salt without any earthy admixture. The other portions have earth mixed with the salt in various proportions, and the effect of the whole reminds

one of rude mosaic work. The following engraving represents a portion of the roofing of a rock pit. This disposition is uniformly observed through the whole thickness of the stratum of rock-salt, wherever a horizontal section is made.

The division between the lower portion of the upper bed of rock-salt, and the indurated clay or stone beneath it, is as exactly defined as that between the upper portion of it and the earth above. In passing through this stone, small veins

of rock-salt are found here and there, running in it in various directions; and whenever a crevice occurs, this is filled up with rock-salt, to which the clay, and oxide of iron, have given a deep red tinge. The engraving represents a portion of the rock taken from the part where it joins the upper bed of rock-salt.

Rock-salt has occasionally been met with in other parts of the country, between Middlewich and Winsford; again, a little lower down the river than Winsford, in sinking for brine; and also in boring for coal at Whitley, six or seven miles

below Northwich; and about two miles north of the Weaver, a bed of rock-salt was discovered, about forty yards from the surface. At none of these places has it been worked, on account of their distance from water-carriage; and it is only from the pits in the neighbourhood of Northwich that rock-salt is now procured. These are at present ten or twelve in number, at all of which the rock is worked in the lower stratum only. The shafts are usually square, and constructed of timber.

The rock-salt is obtained in masses of considerable size, differing in form and purity. They are separated by the usual operation of blasting, and with the aid of mechanical instruments. Before extending the workings in any direction, care is taken to secure a good roofing for the cavity which is to be formed. In doing this, the men employ common picks, working horizontally, so as to form a roofing of the rock, and making this as plane as possible. From its situation, (a few feet above the purer part of the stratum,) the rock obtained during this process is usually of inferior quality, and is, for the most part, employed in the refineries. The depth of the workings from the roofings

depends, in great measure, on the nature of the stratum, and the proportion of it occupied by the rock of the purer quality; or, as it is termed, *Prussian rock*, from the circumstance of its being largely exported to the shores of the Baltic. The cavity thus formed presents a striking appearance; and when illuminated by candles fixed in the rock, the effect is highly brilliant. In some of the pits the roof is supported by pillars eight or ten yards square, which are in general regularly disposed; others are worked out in aisles. The rock-salt is raised to the surface by steam power, but horses are employed underground for conveying the rock to the bottom of the shaft. The men employed in working the rock are paid by the ton, and provide their own tools and gunpowder.*

Sir George Head describes a visit to the Marston pit at Northwich, which has been worked for a period of seventy-five years. "Having waited," he says, "with my conductor a few minutes, till the engineer had put a little steam on, we both stepped into a round tub, and, standing upright,

* The writer is indebted for most of the preceding details to Mr. Henry Holland's "General View of the Agriculture of Cheshire."

holding by the chains, were let down very easily. I cannot express the delight I felt at the scene around me, which surpassed any thing I had anticipated; creating those sensations I remember to have felt when first I read of the pyramids and catacombs of Egypt. Here was a magnificent chamber, apparently of unlimited extent, whose flat roof presented an area so great, that one could not help being astonished at its not having long since given way. Yet there was no apparent want of security, it being sound and durable as if formed of adamant. Here and there pillars, in size like a clump of bricks in a brick-field, tendered their support, presenting to the view an array of objects that broke the vacancy of uniform space. My idea of the extent was as if an area equal to the site of Grosvenor Square, was under cover. In the meantime, the glistening particles of crystal salt on the walls, and the extreme regularity of the concentric curved lines, traced by the tools of the workmen, were very remarkable. Occasionally the mark of the jumper chisel was observable, where recourse had been had to blasting the solid rock. I made a few blows against the side of the mine with one of the heavy pointed

pickaxes in ordinary use, and found it as hard as freestone. Underfoot, the whole surface was a mass of rock-salt, covered with a thick layer of the material, crushed and crumbled to a state that exactly resembled the powdered ice on a pond that has been cut up by skaters. Experiments have been made by boring to a depth of seventeen yards; but they have neither perforated the rock-salt, nor do they at present know the thickness of the stratum. The height of this excavation is about fifteen feet, within which space the salt is estimated as being of the best quality. Above, it is somewhat inferior. I was informed that 35,000 tons of salt were annually dug out of the different levels, and that the area of the whole together amounted to forty-eight statute acres. At one part, there is a vista of 200 yards in length, which has been dignified by the name of Regent Street. Here occasionally pic-nic parties are celebrated; and on a large table of coarse deal boards were evidences of a feast of this description, which had taken place a few months before. An empty jug and a sprig or two of evergreen lay forlorn and neglected, while I observed abundant natural tokens of mice, that had joined in the revelry. These little animals

invariably establish their residence underground wherever men lead the way. At the coal pits at Whitehaven, for instance, they are plentiful at a depth of 140 fathoms, being brought there originally probably in bundles of horse provender. Were it possible within this mine, to provide against the inconvenience of smoke,—there not being any efficacious outlet for its escape,—I cannot conceive a place better calculated, with proper appendages and decorations, to give effect to a fête on a magnificent scale. As it is, and as regards light and smoke, people must be content with a choice, either to have too much of the one, or too little of the other. Every one who descends this pit ought to bring a good Bengal light instead of the preparation vended by the learned chemist of Northwich. This is a yellow powder, a quantity of which being placed on the ground, and ignited, engendered, for a few seconds, a tantalizing glare, which sank exhausted before it was possible to take an adequate survey of the objects around. For ordinary purposes, we had recourse to common tallow candles. Having wandered a long way through vast space, but almost in darkness, we came again to the foot of the shaft. Previous to

ascending, my guide went a little out of the way, in order to carry a pail of water to an old horse, who, as the workmen were absent for the whole day, was standing by himself in perfect solitude, and, till we came, without any light at all. Alone and in darkness, he must, poor fellow! from necessity live for many hours in the year, and pass thus neglected a very considerable portion of his time. He loudly expressed his gratitude for the water, and I took an opportunity of examining his condition while he was drinking. I was surprised to find it particularly good; unlike the flaccid, though fine-coated state of horses in coal pits, his was that of a firm crest, and perfect health; a fact I attribute especially to the salubrious effects of the salt. His stall was comfortable and dry, as was the whole space below contained in the pit. I saw no appearance whatever of water during the whole time I was below."*

The brine was formerly raised in various ways; *first*, by pumps worked by hand; *secondly*, in a few situations which admit of the assistance of a stream of water, a water-wheel was employed; *thirdly*, by horse power; *fourthly*, as the demand

* "Tour in the Manufacturing Districts of England in 1835."

for salt increased, small windmills were used for raising the brine; and *lastly*, steam power has superseded all other methods of pumping. In Camden's time the method of raising the brine was by human labour. He says:—"At Northwich there is a deep and plentiful brine-pit, with stairs about it, by which, when the people have drawn the water in their leathern buckets, they ascend half naked to their troughs, and fill them, from whence it is conveyed to the wich-houses."

The reservoirs into which the brine is pumped up are either large ponds formed in clay and generally lined with brick, capable of containing the consumption of several weeks, or they are wooden cisterns pitched within, which will hold a supply of brine for the consumption of a few days only.

The brines of the Cheshire springs contain a large proportion of salt, but they are not always completely saturated; and, as it is important not to expend fuel in driving off more water than is absolutely necessary, it is always an object with the manufacturer to obtain a fully saturated brine. This is done by placing a quantity of rock-salt in the cistern, into which the brine is pumped, and

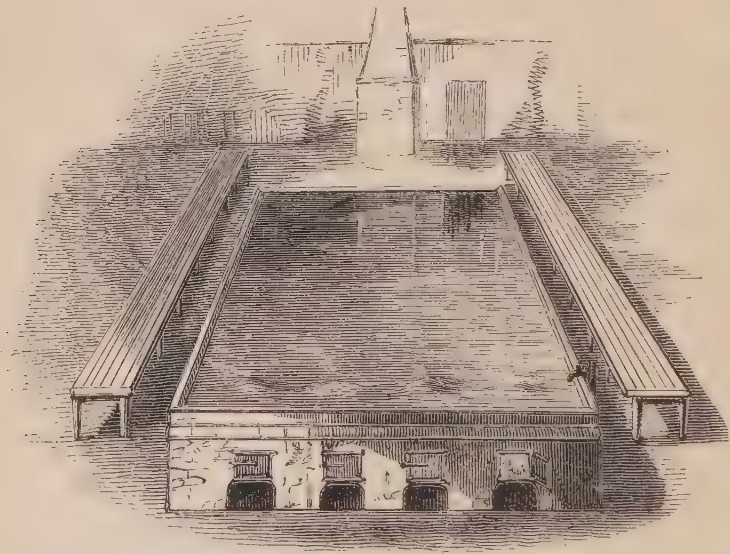
allowing the liquor to act upon it until it is saturated. A strong wooden frame is fixed in the cistern at about half its depth, upon which the rock-salt is thrown, and the earthy residuum is occasionally removed from thence, when all the salt has been dissolved.

In the evidence given before a Select Committee of the House of Commons in 1836, Mr. Worthington, a salt manufacturer of Northwich, thus describes the method of getting to the brine:—"We get to the spring by sinking a shaft down to the brine, which is probably a large lake over the body of the salt. There is usually a strong flagstone over the brine. In getting down the shaft to the flag, we form an inner shaft of smaller dimensions in the first one, and fill the space between the two shafts with a puddle of clay, so as to keep what we term fresh water from mixing with that fully saturated body of brine which we expect to find below the flag. After that body of puddle has become solid, the flag is broken, and usually a large supply of brine flows up the shaft, driving the workmen and their buckets before it. This supply of brine has hitherto been exhaustless. When it has been

necessary to sink a shaft in a different place, it has been from the circumstance of fresh water breaking through and mixing with the brine, thereby making it of no value. The fresh water being the lightest remains on the surface in the shaft, and as you pump up one quantity, all the fresh water in the surrounding ground follows, and instead of pumping brine, you pump up much fresh water with it. Fresh water, however, does not get to the great body of the lake."

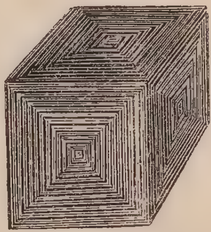
The brine is drawn from the reservoirs into which it is first pumped, as it is wanted, through wooden pipes or by troughs, into the evaporating pans. These are made of wrought-iron, and contain each from 600 to 1,000 superficial feet. Their usual form is that of an oblong square, and their depth from twelve to sixteen inches. There are three or four fires to each pan. There is usually a separate *pan-house* to each pan. At one end of this pan-house is the coal-hole, and the chimney at the other end; along each of the two remaining sides is a walk five or six feet wide, and between these walks and the sides of the pan-house, long benches four or five feet wide are fixed, on which the salt is placed in conical baskets to drain, after

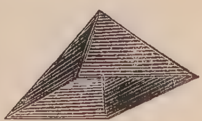
it has been taken out of the pan. A wooden or slated roof is placed over the pan-house, with openings to allow the steam to pass freely out.



The process of manufacture in the evaporating pan, varies according to the kind of salt intended to be produced. The effect of these variations will be best understood by first dissecting a crystal of salt. The natural form of the crystals of pure chloride of sodium is that of a perfect cube, and they constantly assume this figure when the proper

arrangement of their particles has not been interrupted by agitation, or the application of strong heat. "These cubes exhibit diagonal markings or striæ, but frequently on each side produce squares parallel to the external surface, gradually decreasing inwards; circumstances which show the vestiges of their internal structure: for every cube is composed of six quadrangular hollow pyramids, joined by their apices and external surface; each of these pyramids filled up by others similar, but gradually decreasing, completes the form. By a due degree of evaporation it is no difficult matter to obtain these pyramids separate and distinct; or six of such, either hollow or more or less solid, joined together round a centre. If we examine the hollow pyramid* of salt farther, we shall find it composed of four triangles, and each of these formed of threads parallel to the base; which threads, upon accurate examination, are found to be nothing more than series of small





* The bases and altitudes of these little pyramids are in general equal: thus showing the disposition of the salt to form a cube.

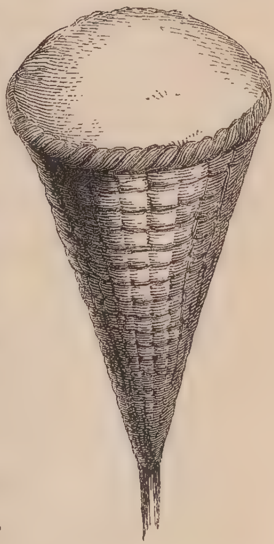
cubes."* The perfect crystallization of the salt can however take place only under the circumstances above mentioned, namely, a freedom from agitation, and the slow and gradual evaporation of the water, which holds the salt in solution; and it is principally on the presence or absence of these causes, that the variation in the appearance of the manufactured salt depends.

To effect the evaporation of the water, heat is applied in various degrees, according to which the product is the *stoved* or *lump-salt; common salt;* the *large-grained flaky*, and *large-grained* or *fishery* salt.

In making the *stoved* or *lump-salt*, the brine is brought to a boiling heat, or 225° Fahr. Crystals of salt are soon formed on the surface, but these subside almost immediately to the bottom of the pan by the agitation of the brine. If taken out each crystal appears at first sight to be granular or a little flaky; but on closer examination, it is found to approach the form of a somewhat irregular quadrangular pyramid. As the evaporation proceeds, similar crystals form and fall to the bottom. At the end of twelve hours, the greatest part of the water of the brine has evaporated; that

* Bergman, Chemical Essays.

which remains being only enough to cover the salt at the bottom of the pan. The fires are then slackened, and the salt is drawn to the sides of the pan with iron rakes. The waller then places a conical wicker-basket or *barrow*, as it is called, within the pan, and having filled this with salt by means of a small wooden spade, he leaves it for a short time to allow the brine to drain into the pan, and then carries it to one of the benches at the side, where the draining is completed. It is afterwards dried in stoves, heated by a continuation of the same flues which have passed under the evaporating pan. It loses, in drying, about one-seventh of its weight. In making this salt the pan is filled twice in the course of twenty-four hours.



On the first application of heat, if the brine contains any carbonate of lime, the carbonic acid quits the lime, which is either thrown up to the surface, when the boiling begins, together with the earthy and feculent contents of the brine, and

is removed by skimmers; or it subsides to the bottom of the pan, along with the salt first formed, and with some portion of the gypsum, and is raked out in the early part of the process. These two operations are called *clearing* the pan: some of the brines scarcely require them at all, and others only occasionally. Dr. Henry found these clearings to consist of, in 480 parts, 384 of chloride of sodium, 20 of carbonate of lime, and 76 of sulphate of lime. Circumstances, however, are continually occurring to vary these proportions even in the same brine.

In making the *common salt*, the pan is filled only once in twenty-four hours. The brine is first brought to a boiling heat, as in making stoved salt, with the double view of bringing it as soon as possible to a state of saturation, and of more readily clearing it of its earthy contents. When these objects have been attained, the fires are slackened, and the crystallization is carried on, with the brine heated to 160° or 170° Fahrenheit. The salt formed in this process is in quadrangular pyramids, or hoppers, close and compact in texture, frequently clustered together, and larger or smaller, according to the temperature employed.

Small cubical crystals will often be intermixed with and attached to these. The remainder of the process is similar to that of the stoved salt, except that after draining in the baskets it is immediately carried to the store-house, and not afterwards exposed to heat.

The *large-grained flaky* salt is conducted at a temperature of 130° or 140°. This salt is somewhat harder than common salt, and approaches nearer to the natural form of the crystals of chloride of sodium. The pan is filled once in forty-eight hours. As salt of this grain is often made by slackening the fires between Saturday and Monday, and allowing the crystallization to proceed more slowly on Sunday, when no work is done, but only a man kept to prevent the fires from going out, the salt has hence obtained the name of *Sunday-salt.*

In making the *large-grained* or *fishery salt,* the brine is heated to 100° or 110° Fahrenheit, so that the evaporation of the water and the crystallization of the salt proceed more slowly than in making the other kinds; and as no agitation is produced in the brine at this temperature, the salt forms in large cubical crystals, seldom, how-

ever, quite perfect. At this temperature, five or six days are required to evaporate the brine.

In the course of these several processes, various additions are, or were formerly, made to the brine, with the view of promoting the separation of any earthy mixture, or the more ready crystallization of the salt. Animal jelly and gluten, blood, white of egg and glue, have been used. These substances being mixed with the brine, coagulate with the heat; and in this way entangling the insoluble matters of the brine gradually rise to the surface, in the form of a thick scum, which being removed, the brine is left clear. In the evidence given before the Parliamentary Committee, in 1835, it was stated that the use of these substances had long been discontinued.

At the time of Mr. Holland's Report, in 1810, *butter*, or some other oily substance, was generally added to the brine during the evaporating process, and after the clearing, to assist the granulation of the salt, and to make the brine "work more kindly." Its use is as follows:—During the evaporation, it frequently happens that the small crystals of salt which form on the surface of the brine adhere together, and instead of falling to the

bottom of the pan, form a kind of crust over a considerable portion of the surface of the brine, thus impeding the evaporation, and, by confining the steam, causes the brine beneath to acquire too high a temperature. When a crust of this kind forms, the salt-boilers say, that "the pan is set over." It is somewhat raised above the surface of the brine, and is usually of an opaque white colour. Now if a very small portion of butter be added to the brine in one of the largest pans, it may be seen in a very few minutes to diffuse itself over the whole surface, and in its progress to occasion any crust which may have been formed on the brine to subside to the bottom of the pan. At the same time a quantity of steam is observed to rise; the superabundant heat is carried off, and the crystallization afterwards proceeds with regularity.

Salt-boilers have also been in the habit of adding alum to their brine when they wished to procure a hard firm salt, of large grain.

But whatever method is adopted to separate the impurities of the brine from the salt, they cannot all be removed from the pan. A portion of these subside to the bottom, and form an incrustation,

which the workmen call *pan-scratch*, or *scale*; which gradually accumulating together with a portion of salt mixed with them, it becomes necessary to remove from the pan every three or four weeks, by *picking*, that is, by heavy blows with sharp iron picks. Dr. Henry found in 480 parts of these pickings 40 of chloride of sodium, 60 of carbonate of lime, and 380 of sulphate of lime. These proportions, however, are subject to variations in different brines. The pan-scratch accumulates most towards the close of the evaporation; for when there is much salt deposited in the pan, it forms such a heavy mass at the bottom, that the water cannot penetrate into it; and hence the portion which is lowest undergoes a sort of calcination and fusion, which gives it extreme hardness, and a very strong adhesion to the pan.

It was long supposed that British salt was inferior, as a preserver of animal food, to the salt procured from France, Spain, Portugal, and other warm climates, where it is prepared by the spontaneous evaporation of sea-water. Hence large sums of money have been paid every year to foreign nations, for the supply of an article which Great Britain possesses, beyond almost any

other country in Europe, the means of drawing from her own internal resources. Some years ago, Dr. Henry, the chemist, instituted a careful inquiry into the subject, feeling how important it was to ascertain whether this preference of foreign salt was founded on accurate experience, or was merely a matter of prejudice; and in the former case, whether any chemical difference could be discovered to explain the superiority of the one to the other.

The result of Dr. Henry's inquiry was, that the slight differences in chemical composition discovered by him in the numerous specimens of salt which he analysed, were scarcely sufficient to account for those properties which are imputed to them, on the ground of experience. The *stoved* and *fishery* salt, for example, though differing in a very trivial degree as to the kind or proportions of their ingredients, are adapted to widely different uses. Thus the large-grained salt is peculiarly fitted for the packing of fish and other provisions, a purpose to which the small-grained salts are much less suitable. Their different powers, then, of preserving food, must depend on some mechanical property; and the only obvious one is the

size of the crystals and their degree of compactness and hardness. Quickness of solution, it is well known, is nearly proportional, all other circumstances being equal, to the quantity of surface exposed. And since the surfaces of cubes are as the squares of their sides, it should follow that a salt, whose crystals are of a given magnitude, will dissolve four times more slowly than one whose cubes are only half the size.

That kind of salt, then, which possesses most eminently the combined properties of hardness, compactness, and perfection of crystals, will be best adapted to the purpose of packing fish and other provisions, because it will remain permanently between the different layers, or will be very gradually dissolved by the fluids that exude from the provisions; thus furnishing a slow but constant supply of saturated brine. On the other hand, for the purpose of preparing the pickle, or of *striking* the meat, which is done by immersion in a saturated solution of salt, the smaller-grained varieties answer equally well; or, on account of their greater solubility, even better.

The specific gravity of various specimens of salt, which is probably connected with the mecha-

nical property of hardness and compactness of crystals, is almost the same in the large-grained British salt as in that of foreign manufacture. "If no superiority, then, be claimed for British salt, as applicable to economical purposes, on account of the greater degree of chemical purity which unquestionably belongs to it, it may safely, I believe, be asserted that the larger-grained varieties are, as to their mechanical properties, fully equal to the foreign bay-salt. And the period, it may be hoped, is not far distant, when a prejudice (for such, from the result of the investigation, it seems to be) will be done away, which has long proved injurious to the interests and prosperity of an important branch of British manufacture."*

During the long period when a high duty was imposed on salt, the collection of this duty formed an important branch of the Excise department. The restrictions imposed on the manufacturer, in order to a proper collection of the duty, were thus stated by Sir Francis Doyle, chairman of the Board of Excise, in his evidence before the Parliamentary Committee of 1835:—

* Dr. Henry's Analysis of several varieties of British and Foreign Salt.—*Philosophical Transactions*, vol. c.

"The duty on salt was collected at certain places, few in number, and where smuggling existed it was not in the collection of the duty at those places, the refineries and salt works; but it was supposed that a good deal of smuggling took place by the misapplication of salt sent out duty free for the cure of fish on the coast, and for exportation. The duty was collected in this manner. The salt made in this country was made in three different modes; either from natural springs of brine which exist in Cheshire and other parts of that neighbourhood, or from the solution of rock-salt in water, or it was made in some places from the natural sea-water. The rock-salt raised from mines was sent under a permit to the different refineries where it was to be converted into culinary salt, and where it was deposited in warehouses into which it was weighed by the officer of excise. When the parties were desirous of dissolving the rock and making it into culinary salt, the officer weighed it out to them, on notice to that purpose. The party then proceeded to dissolve the rock-salt in water, and afterwards conveyed it into pans, and applied heat to the solution till the salt contained in it was crystallized and deposited in the bottom of the pans. When they wished to remove

it from the pans, notice was given to that effect by the trader to the officer, who attended and saw the salt taken out of the pans and carried into a separate warehouse. If the salt was intended for exportation or for the fisheries, it was carried from the pans in a coarse and rough state, and put into a particular warehouse, distinct from the warehouse to which the refined salt intended for home consumption was carried. When put into those warehouses for exportation or for the fisheries, the salt remained there under lock until the trader desired to deliver it out, when the excise officer attended and took an account of the quantity delivered out, and granted a permit; a bond at the same time was given for its proper application. The permit specified the port of exportation, if the salt was to be exported, or the particular fishery if to be employed in the cure of fish; and the time for conveyance was limited to what was deemed sufficient for the purpose. The salt intended for home consumption was conveyed from the pans into a store where it was further dried and prepared, and it was afterwards stored away in another warehouse where it remained to be delivered out. When the trader wished to dispose of this salt

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notice was given to the officer, who attended and took an account of it and charged it with the duty; a permit was then obtained to accompany the salt. And with regard to salt made from natural springs of brine, the brine was in the first instance pumped up from the pits into large reservoirs, from which it was conveyed into pans within the salt works, and the process afterwards was exactly as before described, and the article taken account of and permitted in the same manner. With regard to the salt made from sea-water, the water is run into large earthen flats, water-tight, placed one rather lower than the other. It is first collected in the highest flat, and then conveyed from the one to the other till it reaches the lowest; and when, by the intermediate evaporation, it has become a strong brine, from this it is pumped into the boiling pans within the salt works, and is afterwards treated in every respect as the salt before described." The duty on salt being entirely repealed in the year 1823 these excise regulations of course ceased to exist.

The principal portion of the Cheshire salt, both fossil and manufactured, is sent down the River Weaver to Liverpool for distribution and exporta-

tion; only a small proportion being conveyed to other places by canal and land carriage. The white salt made from the Staffordshire springs is chiefly exported from Hull, while that from Worcestershire finds an outlet at Gloucester. In the year 1844, 13,476,884 bushels of rock and white salt were exported, of which quantity—

Russia took	1,823,756	bushels.
Denmark	462,576	„
Prussia	1,686,520	„
Holland	799,802	„
Belgium	1,041,028	„
Sweden and Norway	237,594	„
Germany	301,426	„
British North American Colonies	1,772,799	„
United States of America	4,664,430	„
Western Coast of Africa	374,452	„
New South Wales	125,801	„
Guernsey, Jersey, &c.	41,032	„

The remaining quantity was sent in small shipments to the West Indies, ports in the Mediterranean, Brazil, &c. The quantity retained for home consumption in the same year is estimated at 12,647,616 bushels.*

* Porter: Progress of the Nation.

LOMNITZER HEAD, CARPATHIAN MOUNTAINS.

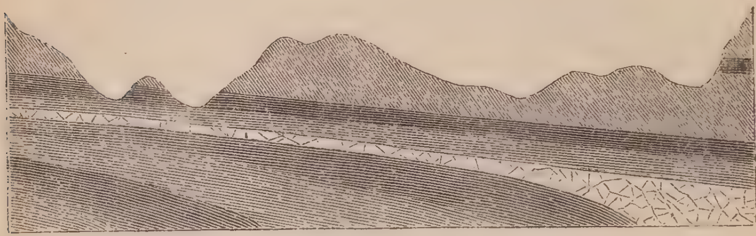
CHAPTER III.

DEPOSITS OF ROCK-SALT IN EUROPE—DESCRIPTION OF THE MINE AT VIELICZKA—VISIT TO THE SALZBERG AT ISCHL—SALT MINES OF THE TYROL—SALT IN THE STEPPES OF SOUTH RUSSIA—FREEZING CAVERNS—SALT MINES OF TRANSYLVANIA—SALT AT CARDONA IN SPAIN—ROCK-SALT IN ASIA—PERSIA—SALT DESERTS—ROCK-SALT IN AFRICA.

THE most extensive and productive deposits of rock-salt in Europe are those of Bochnia and Vieliczka in Galicia. Numerous other deposits are found along each side of the great Carpathian range, and may be said to extend with greater or less intervals all the way from Moldavia to Suabia. This very extensive tract comprehends the salt mines of Wallachia, Transylvania, Galicia, Upper Hungary, Upper Austria, Styria, Salzberg, and finally of Tyrol.

Such deposits form a distinct member in the series of stratified rocks, occurring with limestone, clay, chalk, gypsum, stinkstone, slate, and not unfrequently with bituminous formations. From the following section of the deposit at Wimpfen,

in Wirtemberg, it will be seen how the gypsum is enclosed by a deep layer of shell limestone containing the rock-salt as a separate mass. Some



geologists suppose that the rock-salt in this and similar basins has been deposited from saline lakes, or even by the sea, which once covered and afterwards quitted the place. Dr. Macculloch remarks on this hypothesis: "The purity and solidity of the masses of rock-salt, their bulk, their insulated and peculiar positions, with many other facts on which I need not now enter, prove that they could not have been derived from the ocean in the manner thus supposed, nor probably in any manner. They are special and original deposits in whatever way produced; as of the design we cannot doubt, though no other ends should have been in view than the uses of this substance to man."

The deposits of salt among rocks of almost all ages is an interesting and important fact. Salt is daily accumulating in certain inland lakes and marshes; in Poland it probably exists principally, if not entirely, among tertiary rocks; in the Austrian Alps it is placed in the oolitic system; in Switzerland it is referred to the lias; in Wirtemberg it is in the muschelkalk; in England our greatest salt mines are in the new red sandstone, but there are two or three copious salt springs in the coal formation, from one of which salt has been largely extracted. In certain parts of the United States salt springs issue from old transition slate rocks; and lastly, a spring containing a great proportion of salt rises near Keswick from the lowest division of the slate rocks of Cumberland.*

Among the salt mines of Europe those of Austria are the most important, and of these the celebrated mines of Vieliczka are the most extensive. An excellent description of these mines was published a few years ago by Mr. Kohl, from whose account the following details are selected.†

* Sedgwick and Murchison: Geol. Trans. 1835.

† The account of Mr. Kohl's visit to Vieliczka is included in his work on Russia, instead of that on Austria to which it properly belongs. The translator of the latter work in the

The free town of Vieliczka is an ancient Polish city in the Carpathian Mountains. It is now included in Austrian Galicia, in the circle of Bochnia. The deposits of rock-salt are on the northern side of the mountains. Mines have been formed at Bochnia and Vieliczka in the north, and at some parts of Moravia and Transylvania in the south, and lately at Sambor and Halitsh in the middle of the chain.

The Sarmatians of Herodotus, the Dacians, the Goths, and many other nations wandered for centuries over these countries without ever dreaming of the mineral treasures that lay buried beneath them. They procured from distant shores the scanty portions which they needed of a mineral of which inexhaustible stores lay scarcely one hundred feet beneath them. In the year 1251 the discovery was first made, and the mines of Bochnia and Vieliczka first worked. The mode of working was at first very rude, but after some time miners were brought from Hungary and Germany, and the work was carried on with more skill. This was in the year 1442; but during the whole

"Foreign Library," (1843,) to which we are indebted for our information, has very properly included this description therein.

period of Polish domination, all the arrangements were very imperfect. The mines were leased to Jews, whose only object was pecuniary profit. In 1772 the mines became the property of the Emperor of Austria, and then a more prudent and scientific system of management was adopted.

The higher offices about the mines are now filled by cultivated Germans, and all possible improvements which art or science can suggest are adopted, partly to remedy the defects of the old system, and partly to make the workings more productive. Bochnia and Vieliczka taken together furnish about 900,000 cwt. of salt annually. The quantity raised is, however, regulated by the demand. About 200,000 cwt. are sent to Prussia, and 150,000 cwt. to Russia, at such prices as will just remunerate the Austrian government for the cost of raising and transporting the mineral. The remaining quantity is sold by the government at arbitrary prices in virtue of the salt monopoly which it possesses. This supply is consumed partly in Poland, partly in Silesia, Moravia, and the valleys of the Carpathians. The cost price of the salt sold to Russia and Prussia is said to be only one florin the cwt., including all the expenses

of the works, while the Austrian government sells the salt at five florins the cwt. to its own subjects.

The higher functionaries in the mines are about eighty-six in number: workmen and all included, they amount to two hundred. The former are headed by a governor, and divided into *subterranean* and *upper air* inspectors; or, as they are often called, "gentlemen of the leather," and "gentlemen of the pen." The latter are employed in the administrative department, and the former in the inspection of the workmen, and the superintendence of new works.

Shemnitz, in Hungary, is the principal academy for the instruction of these inspectors. The workmen are of two classes, those who are paid by the year, and those who work by the piece; the number of the latter being increased or diminished with the demand for salt. There are 800 superannuated workmen and inspectors in the receipt of pensions, of whom most have been employed for forty or forty-five years.

There are four great magazines of salt, where it is heaped up in huge storehouses, to which the merchants come to buy it. Smaller stores are kept at Brunn, Teschen, and Bilitz.

The salt-works cover a space of 35,000 square fathoms. The length of the mines, with all their galleries, amounts to 7½ German, or 30 English miles. Ten shafts connect this subterranean labyrinth with the upper world. One of them is used for draining away the water, two for the descent of workmen, and the rest for the raising of the salt, and the descent of the straw, wood, horses, &c.

The whole works are divided into three compartments called *Fields;* namely, the Old Field, the Yanina Field, and the New Field. The Old Field goes in a southward direction from the town into the mountains; the Yanina Field goes eastward, and the New Field westward. The Old Field consists of the irregular works of oldest date. The Yanina Field, named after King John Sobieski, was dug upon an improved plan. The New Field is of Austrian foundation, and has always been worked according to the best principles of art.

Each of these mines consists of five stories, one above another; and each of these stories is made up of numerous chambers, cells, and caverns, connected by horizontal passages. The different

stories are connected by perpendicular shafts, or winding stairs. The descent to the uppermost story is 34 fathoms deep. Between each of the different stories an interval is left of 15 or 20 fathoms. The depth, which has been rendered convenient for descent by shafts and staircases, is 125 fathoms; the entire depth amounts to 145 fathoms. Thus, although Vieliczka itself is 150 feet above the Vistula, and 699 feet above the level of the sea, yet the mines descend 580 feet below the bed of the Vistula, and 300 feet below the level of the sea.

The best kind of salt is the *crystal salt*, as it is called, which is of a snowy whiteness, and transparent as glass. It is found only in small masses, or veins, running through the other salt. Formerly, this kind was always sent to the King of Poland, who made presents of small portions of it to the nobility, and also had it fashioned into various ornamental shapes, for the decoration of his palaces. It was also used for presents to other sovereigns. The King of Prussia still receives annually two hundred weight of this fine salt; the Emperor of Russia, as such, two and a half, and as King of Poland two hundred weight

more. The Emperor of Austria receives three hundred weight as emperor, and one as King of Hungary. The statue of King John Sigismund, formerly at Warsaw, and now in the salt-works, is made of the largest block which has ever been found of this crystal salt. The workmen make all sorts of articles of this salt for strangers, such as books, needle-cases, crucifixes, billiard-balls, necklaces, rosaries, salt-cellars, knives, inkstands, &c., which they sell at high prices. Pieces are sometimes found, which are as transparent and pure as the finest plate-glass. Attempts have even been made to manufacture mirrors of this salt.

In addition to this salt, which is found only in small quantities, there is the *Blotnik*, or *earth-salt*, the *green-salt*, and the *Shibik-salt*. The earth-salt is found in the upper strata, and is often mixed with earth and clay. No trouble is taken to obtain it; but it is necessary to get rid of it, in order to reach the better kinds; and it is either used up in the mines for the building of props, vaults and steps, or it is sold at the mouth of the mine for cattle. The green-salt lies in immense compact masses under the earth-salt, and is the principal object of attention. It consists of small

crystals, which adhere closely together. It is as hard as glass, and is of about the same greenish colour and transparency as the common bottle-glass of Germany. This salt has many subdivisions, according to the quality and density of the masses. The deeper the descent, the whiter, finer, and better does the salt become. The *Shibik-salt* lies under the green-salt, and is less green but more dense than this.

The earth-salt is sold in such pieces as it happens to be broken into, to the inhabitants of the surrounding district, and is not used in commerce. The differences between the various kinds of green-salt are also too insignificant to be noted by the government, which only takes account of the three qualities already mentioned. The crystal-salt is brought up in as large quantities as possible, and is immediately formed into the required shapes by the chisel of the sculptor, or the knife of the workman. The green and Shibik salts are commonly cut into cylindrical or oblong blocks; the former being called *Balvans*, and the latter *formal* pieces. The *cylindrical* form is most common. Balvan is said to be an old Sarmatian idol, the shape and name of which give the name to

these blocks. They are not perfectly cylindrical, but bulge out somewhat in the middle. They are cut into this shape by the workmen in the mine, and are rolled out in wheel-barrows. Each balvan is never smaller than two, or larger than three hundred weight. The oblong blocks are about the same weight. Those pieces which break off during the loosening of the blocks, and which are not large enough to make into balvans and oblong blocks, are called *natural pieces*. They are sold singly by weight; the small fragments are sold by measure. The natural pieces generally remain in the neighbourhood; the small fragments are bought by the peasants; the balvans are sent away by land-carriage, and the oblong blocks by water.

The first strata passed through on descending the mine, consist of clay and sand. At a depth of fifteen fathoms, occur the first traces of salt, consisting of a few small crystals scattered in the clay. Here and there also the clay is intersected by thin veins of salt, or impregnated with numerous particles of it, which are overlooked at the works in the rich abundance of the stores beneath. On descending deeper into the clay, the masses of

salt increase in size from five, ten, or fifteen feet in diameter to fifty or one hundred feet. In the upper parts, these pieces are dirty and mixed with earth; but lower down they become clear, dense and pure. These great fragments lie in all directions, positions, and shapes; they seem to have once formed huge connected masses which have been broken asunder by some great natural convulsion.

Under the old system, the salt was taken wherever it was found, in as great quantities as possible, without thinking whether the neighbouring strata could bear this undermining and scooping away. Wherever anything was built, it was done in a careless manner. A penurious system prevailed in the sinking of shafts, the driving of galleries, in fixing props, as well as in the draining and ventilating of the mines. The passages were frequently made so small, that it was necessary to creep through them. This niggardly system was not only the cause of much inconvenience, but of many accidents, such as the falling in of roofs and passages, occasioning loss of life; and cases have occurred where the upper strata fell in, and whole streets of the town of Vieliczka were destroyed

as if by an earthquake. Under the present management, however, nothing has been spared to remedy these old defects. The galleries have been widened, and well supported with props of timber taken from the forests of Niepolomize, which have been nearly exhausted for the purpose.

In the new mine everything is in the best order. The galleries, as well as the steps leading down to them, are broad and convenient. Where the shafts pass through earth and clay, their sides are supported either with timber or with masses of salt; where they pass through salt, this support is unnecessary. In building with masses of salt, the blocks are erected in the usual manner, and water is then poured over them. The water dissolves a portion of salt, and fills up all the joints; and in evaporating, forms a kind of cement which binds the whole together. In this way walls and ceilings of the greatest solidity are built of salt and water. In excavating the salt in the mine, columns of salt are left at regular intervals, to support the arched roof. These columns have the appearance, in some parts of the mine, of long aisles in a Gothic cathedral. There are about a hundred of

these chambers and vaults, all of which are distinguished by particular names; and there is not one of the superintendents who is acquainted with the perplexing maze. Each knows his own district; but if he venture into other districts, he requires a guide. Portions of the works have not been entered for many years. In fact, the whole workings occupy an area of double the extent of the old town of Vienna.

Mr. Kohl having obtained a card of admission from the governor, drew over his clothes a white linen blouse, and began his descent into the mine down long convenient flights of steps, some of wood and others of rock-salt. There is one grand staircase which was built previous to the visit of Augustus II. to the mine; and another, the *Imperial staircase*, was built for the late emperor and some members of the royal family. Common visitors descend by side steps, which are convenient and safe. Indeed at these works one may ascend and descend as leisurely as on the staircase of a palace.

The Austrians are very reserved on the subject of their salt mines. The greatest secrecy is observed respecting the cost, the prices, and the

quantities of salt raised, as also with respect to mining arrangements, the extent of the works and other circumstances of that kind. Strangers are never allowed to remain long in the mines, and are seldom permitted to repeat their visits. Whenever the workmen leave the mines they are carefully searched; a precaution apparently unnecessary, for in addition to their wages, they receive an allowance of 15 lbs. of salt annually for each member of their families. Care is also taken that none of the saline water which flows from the works shall be collected and used. This water is conducted through subterranean canals into the Vistula, where mixing with the river-water it soon becomes useless. In this way 600 *eimer** of the finest brine, for which in some countries separate salt-works would be established, are wasted every day.

The salt mines of Vieliczka are certainly the most beautiful, as they are the largest in the world. Nowhere is dirt or disorder to be seen; every thing shines and glitters with the purest brilliancy. There are no springs of water at the depths worked

* The eimer is 12½ gallons nearly.

at in the mines, so that fresh water has to be conveyed into the mines from above by means of pipes. Hence the air of the mines is very dry, as is proved by the excellent preservation of the statues carved in salt erected here and there, and which would soon decay in damp air. The miners seemed in as good preservation as the statues; they all seemed very healthy, and some of them had worked in the mines for forty or fifty years. The place seemed also to agree with the horses, which soon get into good condition in the mines, if ever so miserable before. A strong current of air flows through all the galleries, and at certain corners blows with astonishing violence. An extraordinary subterranean whirlwind occurred here in 1745, when the roof of a large vault fell in. The condensed air shot up through the shafts and galleries leading from the vault, upsetting the workmen and their tools in the upper stories, tearing down beams and bursting open doors, and finally throwing down all the buildings which stood over the pit.

Noxious gases are never met with in salt mines. Occasionally, however, at Vieliczka a combustible gas called *Saleter* floats up through the atmosphere

and burns away without doing any harm. Sometimes the fine particles of salt inhaled with the air renders the miners consumptive. The dry saline air is a great preserver of animal and vegetable matter. The meat brought down into the mines becomes naturally salted and keeps for a long time. Dead horses have sometimes been thrown into abandoned workings, and years after the bodies have been found perfect and entire.

The first excavation entered by Mr. Kohl was the Upper St. Ursula's chamber; the next, the Lower St. Ursula's chamber, then the Michaelovitsch, the Drosdovitch, the Emperor Francis, the St. Mary, the Rosetta, and the Pishtek chambers, &c., which have been named after saints, Polish kings, Austrian emperors, and distinguished mining inspectors. On an average each of these chambers is 100 or 150 feet high, and 80 or 100 feet long and wide. In some the works were still going on; others were used as storehouses for the salt. They appeared like huge subterranean vaults of Gothic architecture. Wooden steps leading from gallery to gallery were attached to the walls. The torches and lanterns of the workmen lighted up the walls. One who stood in the highest

gallery lighted a large piece of oakum and threw it down the shaft. It burst into a blaze and the flame lighted up the glittering vault to its highest summits and revealed fresh and unknown depths below. The old mines are very picturesque, particularly where the roofs dividing the stories have fallen in, thus opening abysses to the view at which the spectator shudders. The new mines with their regular beams and props, massive even walls, and strong neat chambers, are less wild and striking. In some caverns, immense chandeliers, cut out of the salt, have been hung up. In one, which was called the Great Hall, hung such a chandelier, 35 feet in height, and 60 in circumference. In another, the Lentov chamber, were six of these chandeliers.

Some of the old salt caverns have been converted into stables; others into chapels and churches. The largest chapel is that of St. Anthony of Padua. It was built in 1698, and mass was regularly performed there every morning to the miners until it was abolished by Joseph II. Every year, however, on the 3d July, service is performed there, followed by a grand festival. All the inspectors and workmen are dressed in their holiday

clothes, and they dine at long tables, spread out in the salt caverns. In the chapel, every thing is carved out of rock-salt—altar, walls, ceiling, doors, crucifixes, niches, pedestals, and the statues upon them, of St. Anthony, St. Dominic, St. Francis, St. Mary, St. Kunigunda, and the Bishops Stanislaus and Casimir. The light of a torch held behind one of these statues pierces through its thickest part. It is remarkable how little some of these statues have suffered, though they have remained here more than a century. The sharpness of their features alone seems to have worn down a little. Mr. Kohl saw an old workman busy sharpening them up again with a hammer and chisel. As he could only raise the nose by cutting at the cheeks, and the lips by cutting at the chin, he certainly did not improve their physiognomies.

Works of this kind are numerous in the mines. Salt obelisks are erected as memorials of royal visits, and salt monuments of different festivals. In addition to St. Anthony's Chapel, there is the Corpus-Christi Chapel, in which every year on the 3d September, service is performed in memory of the visit of the late Emperor Francis. The

oldest statue in rock-salt is that of the Polish queen, Kunigunda, the foundress of the mine. Around it hang old lamps of cut salt. The most interesting trophy is a great Austrian eagle, surrounded by all the tools and implements used in the mine. This is in the Old Ball-room, the walls of which are resplendent as with the lustre of thousands of diamonds. Here the subterranean fêtes are given, and the illumination on these occasions surpasses the most magnificent ball-rooms in splendour.

The stables, stalls, and troughs of the horses are also of salt. There are generally thirty or forty of these animals in the mines, and when once brought down they never see the light of day again. And yet this apparently unnatural mode of life, as already stated, agrees with them. Their duties are to keep the machinery in motion, and to transport the large masses of salt. The grooms who attend them are often down in the mines for weeks together. All the other workmen leave the mines after eight hours' work. When horses are to be taken down, they are fastened into a long basket, and let down by a rope. At first they resist this,

but lie quite still the moment they get into the darkness of the shaft.

Mr. Kohl describes the subterranean ponds or lakes as the most wonderful of all the wonderful spectacles which these caverns and vaults present. There are nearly twenty such, on which a few small boats are kept. Mr. Kohl was rowed over two which are connected by a canal. Each was several hundred feet long, and about twenty feet deep, and far above them arched the huge salt rocks. "Never had a breath of wind troubled the surface of these waters; never had a swallow fluttered over them, or a lily bathed its petals in them. Moved as if by an invisible hand, the silent boat floated over the smooth, tranquil surface. We seemed as if in another world, for even the sounds which broke the silence were strange and unfamiliar. We had taken some pieces of salt with us, which we dropped into the middle of the water, and the sound was as if we had struck the deepest bass chord of a harp. The echo lasted for several seconds, but did not seem to come from the rocks around, but to be reverberated from the depths of water."

In one of the subterranean chambers a little

museum has been collected, containing all the varieties of salt, and other substances found in the mines. There are to be seen shells imbedded in salt,* petrified and salted wood, masses of salt with stones in them, pieces of clay containing particles of salt, and salt crystals in various, curious, and fantastic shapes. Some are remarkable for their odour, which is sometimes like that of truffles, others like that of phosphorus, others again like that of sulphuretted hydrogen.

Four hundred cubic fathoms of this rock-salt yield 5,000 tons of salt. Now, as 35,000 tons of salt are obtained annually, the mines must be enlarged every year to the amount of 2,800 cubic fathoms, which is equal to a solid cube of 80 feet. It would be easy therefore to calculate about how much salt has been taken from this mine since its first establishment. The hundred great vaults which the mines contain have always yielded the principal part of the produce. On an

* A mass of rock-salt with shells in it, from this mine, was examined by Professor Philippi. On dissolving the salt he discovered forty species of animal remains: viz. 5 zoophytes, 14 polythalamæ, 1 echinus, 1 serpula, 7 conchifers, 8 univalves, and 3 crustaceans. A cerithium was identified with the *C. Lima* now living in the Mediterranean.

average each of these vaults contained 2,000 cubic fathoms of pure salt, and the aggregate amount of their contents would be 200,000 cubic fathoms, or 2,500,000 tons of salt. In this computation is not included the quantity gained from the shafts, passages, stairs, &c., which would double the amount. The total would be 5,000,000 of tons, which is probably near the truth; for this would give for each year an average of between twelve and thirteen thousand tons of salt. If the price of a cwt. of salt has on an average been three florins, these mines have, during the 400 years of their existence, set a capital of three hundred millions of florins in circulation; and, estimating the average consumption of every man, woman, and child, at ten pounds weight, have furnished three hundred millions of human beings with salt.

The deposits of rock-salt at Ischl, which we are now about to notice, are situated in the circle of Salzburg, or of Salzach, in Upper Austria. The accompanying section of the works will convey a correct notion of the position of the salt mass, among the beds of limestone rock in which they are imbedded. The beds under the salt are argilla-

ceous, and contain some bands of dark-coloured limestone. Over these beds, and immediately under the salt mass, are some thin, compact cherty beds of limestone. The salt mass is a confused, irregular compound of gypseous and saliferous marls, &c., which has been worked at the lowest level, through a breadth of about 500 Vienna feet, and through a depth, between the highest and lowest levels, of about 1,500 feet. These different levels are approached by means of twelve horizontal galleries, cut through the inferior beds. Here, as at Hallein, the salt mass s, is separated from the surrounding limestone by bands of dark-

coloured gypseous marls, G, not saliferous. The superior beds of limestone are hardly to be distinguished, either by their structure or their fossils, from those which underlie the salt.* The position of the town of Ischl is shown at I.

In July, 1829, Dr. Tobin visited the *Salzberg*, or salt mine at Ischl. It was illuminated for the occasion. "We set out," he says, "at about one o'clock, a long string of carriages, and, after an hour's drive through a very pleasant valley, we arrived at the foot of the mountain, which contains the mine. Here a number of miners were waiting with sedan chairs for the ladies, many of whom, however, preferred walking up the mountain, and, in about three-quarters of an hour, we arrived at the chief entrance of the mine. We were now to be attired, as is usual on entering the mines, in a long white mantle or frock, and a large white broad brim; the latter to hinder us from knocking our brains out, and the former to keep our clothes clean. Here was confusion dire: this frock was too small, this too long; this lady had no brimmer, this gentleman could find no stick. I laid hold of the first frock that I met with; but up came a

* Sedgwick and Murchison: Philosophical Magazine. 1830.

lady and begged I would exchange with her, as her frock was so long she could not walk in it, and mine so short that it did not reach to my knees. *La grand toilette* at length finished, the ladies were placed in their carriages; that is, two in each wheelbarrow, face to face, with a miner before to pull, who carried a lamp in his hand, and another to push behind, and between every two barrows went another miner bearing a paper lanthorn. The gentlemen were, of course, on foot, with the exception of one or two lame invalids.

"In this guise, with half-a-dozen miners going before, carrying lamps, the whole train entered the passage, and in a few seconds lost sight of daylight. After a long, wet, and, in spite of our many lamps, dark journey through this narrow and low passage, where my head was continually coming in contact with the roof, we came to the *rutsch*, or slide, which leads down into the salt chamber. This rutsch is formed of the trunks of two large fir trees laid close together, rounded and polished, and placed in an oblique direction, in an angle of about forty degrees; a miner with a lamp in one hand, places himself astride these trees, and holds with his other hand a cord which is fixed to the

rock on the sides. The person who wishes to descend seats himself behind the miner and holds him by the shoulders. The miner then lets the cord slip through his hands, and down they go like lightning into what seems an abyss of darkness. Safe at the bottom he gives a shout that the next couple may follow. When the *rutsch* is very long, as in the mines at Hallein, near Salzburg, the miner always sits upon a thick leather apron, and when alone makes no use of the cord, but rushes down with a fearful impetus into the salt cave below. When we arrived at the *rutsch* and the ladies had all got out of their barrows, after much discussion and many fears and doubts, they consented thus to descend, as the miners assured them it was more dangerous to do so by the steps cut in the rock at the side, which were exceedingly precipitous and very wet. Having reached the bottom of the *rutsch*, which ends in a slight curve to break the impetus of the descent, we found ourselves in an immense cavern, or room, excavated in the rock, about 12 feet high, and from 10,000 to 12,000 feet in circumference, supported in the middle by a massive pillar of rock, and lighted up by some hundred lamps, which however only

served to give the scene a more awful and gloomy appearance. The visitors, whose number was considerable, in their long white mantles and hats, looked like spectres wandering in the shades of another world. The roof and walls of this cavern were covered with minute crystals of salt, not, however, sufficiently large to give to it the glittering appearance which I had expected. The mountain contains a great many of these salt chambers, which, at different periods, are filled with fresh water, conducted into them by wooden pipes. When this has dissolved a sufficient quantity of salt, which operation occupies some months, it is drained off through a deep perpendicular shaft near the middle of the cave, and is then conducted through wooden pipes, often for a very great distance, to the boiling-houses, where it undergoes the process of evaporation.

"Having wandered through these gloomy abodes of silence and night for some time, we ascended the stairs, the ladies resumed their seats in the barrows, and the procession returned as it had entered. To save my head from additional thumps to the many it had received on entering, I took the place of one of the pushers, and, after a merry drive of

about twenty minutes, we again saw daylight, like a distant star, increasing in size till we reached the entrance of the mine. We here unspectred ourselves, and returned home in our usual terrestrial appearance, and a merry party we were."

The boiling-house, where the salt solution is evaporated, is situated at the extremity of the chief street of the small town of Ischl. It is a large

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circular building, containing an enormous iron boiler or pan, between thirty and forty feet in

diameter, and a foot and a-half in depth. In this building, baths are fitted up for invalids who bathe in the *mother-water*,—a residue which remains after the greater part of the salt has been crystallized out of the salt-water by evaporation. This bath-water is an intensely strong solution of chloride of sodium and other salts, and is diluted according to prescription for the various patients. The same solution of salt is also employed for *douche* and shower baths. The vapour baths are arranged in a curious manner. Above the large boiler is the pan house; on the scaffolding which supports the roof, and from which the boiler is suspended, a number of small closets are erected, in one of which the person taking the bath is seated, so that he is not only completely surrounded by the vapour of the boiling salt-water, but breathes an air impregnated with many volatile particles. These baths are used twice a day, and the patient usually remains in his cabinet, or walks along the gallery suspended over the pan, from one to two hours at a time, which proves in many cases of great utility.

The salt mines of the Tyrol also belong to the Austrian Government, and are situated near Hall,

in the valley of the Inn. The manufactory at Hall has been carried on ever since the commencement of the fourteenth century. The native salt, at four leagues' distance, after being dissolved in

HALL.

water at the mines, is conveyed to Hall in little rivulets, which flow in troughs made for the purpose, there to be reconverted into crystals. Nine caldrons are employed; the five largest of them about thirty-six feet in diameter. They are made of iron, and have an opening at one side, by a joint, in order that they may be cleaned from

salt when necessary. The salt-water being previously heated, is admitted into the caldrons, to the depth of eight inches, and is kept in a state of ebullition during three hours, at the end of which time, two inches and a half have been evaporated, and a great quantity of salt deposited. Each boiling in each caldron will produce from twenty to twenty-four quintals, (from 2,000 to 2,400 lbs.;) so that one caldron will produce, by the ordinary number of boilings, 170 quintals of crystallized salt. This amount for each of the five large caldrons, and half of it for the four smaller, will yield 1,202 quintals, or 120,200 lbs. per day from the whole manufactory. The value of the salt produced is about 100,000*l.* sterling per annum; and, deducting the expenses of the establishment, a clear revenue of nearly 80,000*l.* is obtained.

On leaving Hall to visit the mines, Mr. Inglis says:—"In less than half-an-hour, I found myself at the foot of the chain of mountains that bound the valley to the north, and at the mouth of a narrow ravine, traversed by a furious torrent. A path leads up the ravine towards the mines, which lie about eight miles further in the heart of the mountain. I have seldom ascended a steeper path

than this, or one more interesting from the sublimity of the scenery that lay around. The grandeur of the views, and the ruggedness of the objects, in traversing a gorge that penetrates so many miles into the recesses of the mountain, may be imagined; and perhaps it is better to leave all to the imagination, than to attempt a description. Enormous masses of overhanging rock seemed to be suspended above, almost by a miracle; old pine forests hung upon the rugged cliffs; the torrent that rushed by was here and there spanned by bridges of snow, while huge unmelted avalanches lay in its bed; cascades tumbled from a hundred heights, some close by the path, some heard at a great elevation above; while peaks, some dark, some snowy, many thousand feet high, almost closed overhead, and seemed to jut into the sky. At length, in the midst of this wild scene, a cluster of houses are seen above, where the gorge loses itself among precipices; and where the torrent has separated into a hundred tiny feeders, oozing from the beds of snow. At this wild spot stands the miner's inn." Mr. Inglis here met with the superintendent of the mines, who invited him to breakfast; after which, he says:—" I proceeded

to visit the mines, clothed in a suitable dress, and with a staff in my hand, and preceded by flambeaux, I followed my conductor into the mine. The visit commences with a descent of 300 steps, when one may fairly believe himself in the bowels of the mountain. It is a strange empire one finds in these dismal abodes: life is a different thing when sunlight is withdrawn; and there is an icy feeling falls upon the heart, as well as on the senses, when we look around these dismal galleries and dark walls, dimly lighted by a few ineffectual flambeaux, that convey truly the idea of 'darkness visible,' and scan the dark subterranean lakes, whose extent and profundity the eye cannot guess but by the plunge of a fragment of the roof, and the dim glimmer of the lights; and hear the distant stroke of the miner's axe far in the interior of the caverns; and still more do we feel the difference between the world above and regions such as these, when we reach the solitary miner in some vast cavern, with his single candle, striking his axe ever and ever into the dull wall: but along with these feelings, astonishment and admiration are engendered, at the power of man, whose perseverance has hollowed out the mountain; and with

his seemingly feeble instruments—his human arms, and little axe, has waged war with the colossal works of nature.

"The results are indeed almost incredible. No fewer than forty-eight caverns have been formed, each from one to two acres in size; one of the galleries is three leagues in length; and I was assured, that, to traverse all the galleries, six whole days would be required. The manner of proceeding is thus:—when these subterraneous caverns are formed, the miners detach fragments of the native salt from the roof and walls; and when the cavern is sufficiently filled with these, pure water is let in, which dissolves the salt, and the water thus impregnated is conveyed by the conduits from the mines to the manufactory of Hall. When I visited the mines, some of these caverns were dry, and the miners were employed in them; others were salt-lakes, in which the more silent operation was going on. Occasionally a distant hollow sound is heard, approaching nearer and nearer, which one might easily mistake for the rushing of water; this is occasioned by the little chariots which carry away rubbish to the mouth of the mine; the path is a railroad, and

these little chariots fly along it with frightful rapidity. When the sound is heard approaching, it is necessary to retire into one of the niches that are formed in the wall; and the young miners seated in front of the chariots, seem, as they rush by, like gnomes directing their cars."

About 300 miners are employed in this mine. Their wages are very low. They are paid according to seniority;—the oldest get thirty kreutzers,* the youngest about fifteen. They work and rest four hours alternately, and Sunday is a holiday, as well as the great feasts of the Roman Catholic Church. There are two superintendents, who live by turns, each two months at Hall and two at the mines. Their salary is 800 florins (66*l.* 13*s.* 4*d.*), with house and fire-wood free. During the winter months, the long continuance of a storm frequently obliges one person to remain at the mines four months instead of two. Mr. Inglis remarks, in conclusion, that, "interesting and curious as a spectacle of this kind is, it is impossible to be restored to the common sun and air without a feeling of satisfaction; we are almost surprised to find how genial the sunshine is, and how beautiful the sky,

* 60 kreutzers = 1 florin = 20 pence English.

and we drop with cheerfulness a mite into the poor miner's box."*

Turning from Austria to Russia, we find that rock-salt occurs in some parts of this vast empire. In the parched and undulating steppes of the Kirghis in South Russia, rock-salt is found in abundance. These steppes are made up chiefly of reddish sandy marl, and whitish gypsum, in which the rock-salt appears as a vast irregularly-formed mass. The salt protruding at certain points of the surface had long since led the Kirghis, or original nomadic inhabitants of the soil, to make use of this necessity of life; but it is only in latter years that the Russians, regularly occupying the spot, have laid bare a large portion of the mineral. By sinkings in the neighbourhood, they have further ascertained, that, undulating at slight depths beneath the surface, the rock-salt extends over an area having a length of two versts,† and a width of rather more than an English mile. Selecting one of the most favourable situations within this space for the open works, or where the ground rises to a little height above the ordi-

* The Tyrol, with a Glance at Bavaria. 1833.

† The verst is about two-thirds of an English mile.

nary drainage, the Russian miners have exposed a broad surface of salt, and have cut into the rock to the depth of about seventy feet. The mass is crystalline, of a white colour, without a stain, and so pure, that the salt is at once pounded for use without further preparation. The first view of this bright mass from above conveys the notion, that it is composed of horizontal beds,—an appearance, however, which is caused by the method employed to extract the salt.

To form an idea of these features, the reader must imagine an open quarry, from which the upper portion of the salt has been removed, with men at work on different horizontal stages. Long lozenge-shaped pieces, in process of extraction, at different levels, are seen to be divided from the mass by lateral vertical joints, which have been cut open with the hatchet. The block thus squared is then completely separated from the body of the rock beneath by heaving against its free end a huge beam of wood, which swings upon a triangle, and is worked to and fro by a company of the miners. Owing to the crystalline and brittle nature of the substance, a few violent jars only of this battering ram are required to sever the mass

from the parent rock; and thus a vast amount of labour is saved, which at Vieliczka and other salt mines, is employed in the extraction of the mineral. This process of side cutting and horizontal battering necessarily produces in the body of the salt a direct resemblance to many stone quarries, with their natural joints and floors.

In this great salt-quarry, the upper surface of the salt having been corroded by the long continued action of rain-water and melted snow, which percolates through the thin cover of red sand and marl, the result has been the formation of a number of needles, which are good miniature representatives of the snowy *aiguilles* of the Alps. On that side of the quarry which has been worked to the greatest depth, and is now abandoned, the atmospheric action, smoothing away every irregularity, has left a vertical glassy cliff, from fifty to sixty feet high; and the water lodged against its base during the spring period of the Russian *debâcle*, or breaking up of the ice, has excavated and dissolved the salt to the height of the spring floods, leaving a dark cavern, over which the saline mirror seems suspended, and hanging from the bottom of which are stalactitic crystals of salt.

As the floor of this immediate district consists of rock-salt, every pond of water, supplied either by springs which rise up from beneath, or by rain-water which rests upon or communicates with the salt, is intensely saline. One of these ponds is described as a pool of bright, transparent, greenish water, in which myriads of small animals, peculiar to brine-springs, are seen in lively agitation. This pool is used by the natives as a bath. Sir R. Murchison bathed in it, and had great difficulty in sinking the body.

In addition to the floor of salt, this spot is marked by two or three hillocks of gypsum, one of which, on its south side, assisted by artificial excavation, is used by the inhabitants as a cellar. This cavern has the very remarkable property of being so intensely cold during the hottest summers as to be filled with ice, which diminishes in cold weather, and entirely disappears in winter, when all the country is covered with snow.

" Standing on the heated ground," says Sir R. Murchison, (the thermometer in the shade being then at 90° Fahr.,) " we can never forget our sensations, when a poor woman to whom the cave belonged, unlocked a frail door, and let loose a

volume of such piercing cold air, that we could not avoid removing our feet from the influence of its range. We afterwards, however, subjected our whole bodies to the cooling process by entering the cave, which, it must be recollected, is on the same level as the road-way or street of the village. At three or four paces from the door, on which shone the glaring sun, we were surrounded by the half-frozen quass and provisions of the natives; and a little further on, the chasm, bending slightly, opened into a natural vault, about twelve to fifteen feet high, ten or twelve paces long, by seven or eight in width. This cavern seemed to ramify by smaller fissures into the body of the little impending mount of gypsum and marl. The roof of the cavern was hung with undripping solid icicles, and the floor might be called a stalagmite of ice and frozen earth. As we had no expectation of meeting with such a phenomenon, we had left our thermometers at Orenburg, and could not, therefore, observe the exact degree of cold below the freezing-point. The proofs of intense cold around us were, however, abundantly decisive for our general purpose; and we were glad to escape for a few minutes from this ice-bound prison, so

long had our frames been accustomed to a powerful heat."*

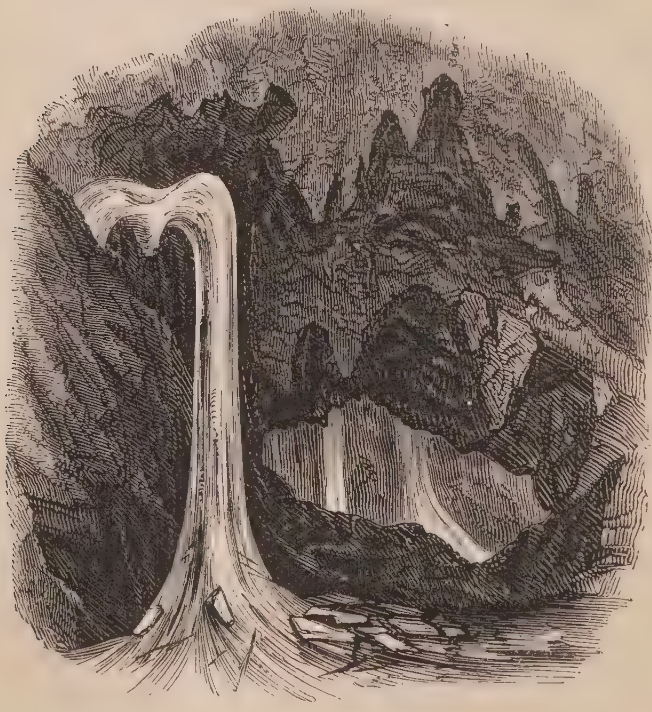
The phenomena of this remarkable cave have been explained by Pictet, with reference to similar caves in Italy and Switzerland. In these caves, as well as in certain mines with vertical shafts above them, and horizontal galleries on the lower sides of the hills, the downward current of air during summer must acquire during its descent the temperature of the vertical portion of the crevices through which it passes; that temperature being in general at least as low as the mean temperature of the place. He also supposes that the air descending through the fissures in the strata, must be still further cooled by the refrigerating effects of evaporation, derived from the moistened materials which it encounters in its progress. In the Russian cave, numerous icicles hanging from the roof of the cavern, and the crust of ice on the floor, indicate a previously wet and damp roof, affording a passage to water; whilst the excessive dryness of the external air of these southern steppes must contribute powerfully to the cooling effects of evaporation. In the plains

* The Geology of Russia in Europe. By Sir R. J. Murchison, &c.

of Orenburg, the great wetness of spring caused by the melting of the snows, is succeeded by an intense and dry Asiatic heat. These conditions co-operating with the form of the grotto, the fissures above it and the horizontal opening into it, at the foot of the hill—features quite analogous to the vertical shafts, and horizontal galleries of mines referred to by Pictet, seem to explain satisfactorily the phenomena of the ice cavern of Illetzkaya. Of course, in winter or in the damp weather of spring, there would be little or no evaporation within the cavern, and the temperature of the internal air being similar to the external, the ice would disappear and the cavern be restored to the moderate temperature of the climate.

Mr. Paget, in his Travels in Hungary, has given a drawing, and a description of one of these ice caverns at Demenfalva. The approach to it was along the rocky bed of a mountain torrent. The mouth of the cavern was a small hole at a considerable height on the side of a limestone rock in a very wild and beautiful valley. The entrance not more than three feet high, opens into a high passage, which descends rather suddenly for several hundred feet, and leads into the first

cavern, the roof and floor of which are beset with stalactites and stalagmites, though not of any great size. "From thence we descended by a broken and very rotten ladder, into a larger cavern, out of which a low archway conducted us to the ice grotto. In the centre of this grotto, which is rather small, rises a column of beautifully



clear ice, about seven feet high, on which the water falls as it drops from the ceiling, and imme-

diately freezes. The floor is one mass of thick ice. Still lower in the same direction, is a much larger chamber, where an ice pillar of several feet in thickness, reaches from the roof to the floor. It is formed of small irregularly-rounded crystals of ice, of about the size of drops of water, which reflected most brilliantly the light of our torches as it fell on them. It is the presence of the ice in this cavern, and the various shapes it puts on, which imparts to Demenfalva its peculiar interest and beauty. We have already seen it forming the slender column and the stately pillar; a little further on it presents in wonderful exactness, the beautiful appearance of a frozen waterfall; in one place it hangs in such graceful and delicate folds, that the statuary might borrow it as the beau ideal of his drapery; while in another it mocks the elaborate fretwork of the Gothic roof. It was singular to observe the apparent uncertainty as to whether ice or solid limestone should result from the water which trickled through the roof; in one instance where the roof of the cavern was covered with hard limestone stalactites, the floor was composed of icy stalagmites. It seemed as though the one or the other was indifferently formed. . . .

Ice is also found in an old mine at Herrengrund, as well as in one or two other caverns in Hungary. That of Herrengrund is remarkable as having only begun to form on the miners opening an old shaft, and as having proceeded so fast as to oblige them to discontinue the workings. It is said still to go on increasing, though much is consumed in summer by the inhabitants of Neusohl, for whom it forms a common ice-house; nay, so well does it answer this purpose, that the greater the heat of the summer, the more rapidly is the ice said to increase."

The same writer describes a visit to the salt mines of Szamos Ujvar in Transylvania, which consist chiefly of three vast subterranean chambers. On descending a flight of steps into the mine, the salt soon became perceptible. After passing some new workings, "we descended to the lower workings; we entered at one end of a vast hall 270 feet long by 180 feet wide and 210 high, with a Gothic arched roof, dimly lighted by the candles of the miners. At the opposite end to that by which we entered was a huge portal, reaching nearly to the top of the chamber, and affording entrance to a second, and that again to a third hall, of equal

extent with the first. On a signal being given, a sudden blaze burst forth in each of these chambers and lighted up the whole space with a brilliant illumination. It was the grandest sight I had ever beheld. The walls were of solid rock-salt, which, if not so dazzling as writers are generally pleased to describe it, was extremely beautiful from the variety of its colours. It resembled highly-polished white marble veined with brown, the colours running in broad wavy lines. The size of these halls, the effect of the light, the grandeur and extreme simplicity of the form, with the exquisite purity of the material, impressed me with a feeling of their architectural beauty beyond that of almost any object of art I know. No words can express the intense enjoyment with which I regarded them."

Numerous workmen were employed on the floor of the chamber in detaching and shaping vast masses of the salt rock. It is cut by means of sharp hammers, into long blocks of about one foot in diameter; these are afterwards broken into masses of nearly sixty pounds each for the market. The workmen measure the weight with great accuracy. After shaping his block the miner calls

to two or three of his comrades to aid him in detaching its base from the rock, which is effected by repeated blows of heavy hammers on the upper surface, the most exact time and equality of force being maintained.

About three hundred workmen are employed in this mine, consisting of Magyars, Wallachs, and Germans. They begin their work at three o'clock in the morning, and leave it at eleven; and the average rate of wages for eight hours' labour is about ten-pence. The temperature of the mine is the same in winter and summer (about 62° Fahr.) The employment is far from unhealthy, and even children often apply themselves to it.

The quantity of salt annually produced from these mines is 600,000 centners, all of which, with the exception of about 30,000 used in the neighbourhood, is sent to Hungary. The *dust-salt* produced by the hammering is thrown into the river as waste. The cost of the salt, including all expenses, is about ten-pence the centner at the pit's mouth. It is sold in Transylvania, at 3½ florins, or 7*s.* the centner; and at Szegedin it is sold at 15*s.* the centner.

This enormous increase in price is a conse-

quence of the salt mines being a monopoly of the crown. In the year 1800, the price of salt was half a florin, or 1*s*. per centner. The long and exhausting wars, which brought on two national bankruptcies within a few years of each other, were an excuse for raising this price to 3½ florins in Transylvania, and 7½ in Hungary. The tax is exceedingly unpopular, and leads to various evils. The farmers cease to give salt to their cattle; and thus, by causing an enormous diminution in the demand, inflict great injury on the revenue. But a still greater evil is the encouragement which this heavy tax gives to smuggling. The whole line of frontier, from the Adriatic to the boundaries of Russia, is well adapted for smuggling. The government salt-officers informed Mr. Paget that they themselves bought their salt from the smugglers! "I have been shown," he says, "the salt-smugglers' paths on the frontiers of Wallachia, where they often come over with whole troops of laden horses. I have heard from the country magistrates, that it was ridiculous to attempt to oppose them; that they had the sympathy of the peasantry with them, and were not only able to bribe the border-guard, but that they came in

such numbers, and so well armed, that they did not dare even to make a show of resistance. I doubt if there is one great proprietor in the south of Hungary who uses government salt, except in such quantity as decency requires to blind officers who do not wish to see."

Near Szovata, the attention of our traveller was attracted by a small green hill, which, on a nearer approach, proved to be a mound of rock-salt, as white as snow when seen near, but covered at the top and in many places on the sides by a layer of clay, on which grass and trees grew abundantly. The approach to this hill was across a little brook, the banks of which, and the numerous stones which stand out from its shallow bed, were all encrusted with crystals of salt, in the form of hoar-frost. Guards are placed about the hill, to prevent the peasants from stealing the salt. The salt-bed, which extends to a considerable distance, is not worked; but in spite of the guards, stealing goes on to a considerable extent; "indeed, one of the first necessaries of life, so costly if bought, and here in such abundance, and to be had for the trouble of picking up, must offer too strong a temptation for the poor man to

withstand. Probably, too, the guards themselves are the greatest robbers. There seems to be no end to the quantity of salt in this neighbourhood; in many places the peasant has only to scrape away the dirt of his cottage floor, to obtain salt beneath it. It is said that in Transylvania alone there is sufficient salt to supply all Europe for some thousand years." The cliffs of this neighbourhood are very beautiful. In some, the rain has formed channels and furrows, which again have given rise to pinnacles, covered with bright crystals of salt, something like Gothic minarets in miniature. The neighbouring salt-works of Maros Ujvar, on the banks of the Maros, are conveniently situated for transporting salt. This salt-bed is said to be of even greater extent than that of Szovata, though it generally lies deeper. Instead of the bright white colour before observed, the salt here is of a dark green hue. In the neighbouring village of St. Pal is a salt-marsh. Though no salt-bed is seen, yet the brook, the springs, the marsh, and even the herbage, are all strongly impregnated with salt. "We were obliged to send some miles off to obtain fresh water, for to us the salt water was intolerable:

though from habit the people of the country drink it without injury."

The north of Hungary is supplied chiefly from the mines of Vieliczka already noticed.

The next most considerable deposit of rock-salt in Europe is at Cardona in Spain. The mines occupy the head of a small valley in the immediate vicinity of Cardona, a town in the province of Catalonia. The valley extends about half-a-mile in length, from the river Cardonero to the mines, in a direction east-south-east to west-north-west. Its north-western side is bounded by a very steep and lofty ridge, the summit of which is crowned by the town and castle of Cardona. The opposite boundary is somewhat less elevated; but both sides are considerably higher than the upper surface of the fossil-salt. On entering this valley, the attention is arrested by bold cliffs of a greyish white colour, which are soon discovered to consist of one vast mass of salt. The sides and bottom of the valley are composed of reddish brown clay, exactly similar to that found in the salt district of Cheshire, forming a thick bed, from which here and there large imbedded masses of rock-salt project in the manner of mere ordi-

nary rocks; especially along the winding ascent which leads up to the town of Cardona. The summits of the ridges which bound the valley on each side are formed of a yellowish grey sandstone, of a coarse texture, and containing many scales of grey mica. The great body of the salt forms a rugged precipice, 400 or 500 feet in height, at the upper extremity of the valley, and is covered by a thick bed of the clay just mentioned. The precipitous form is partly owing to the manner in which the mine has been wrought for a series of ages. There is no excavation, but the salt has been procured by working down perpendicularly, as in an open quarry. The lowest part of the present works has a solid floor of pure salt, which is not above the level of the bottom of the valley, where no salt is found; but the real depth of the bed of salt has not been ascertained. The upper surface of the salt is not level, but appears irregularly elevated, according to the general outline of the hill in which it occurs.

The salt has been usually represented as forming an entire mountain; but though it here appears as supplying the place of common rock, yet, from its being confined to this valley, and not

attaining so high a level as the surrounding hills, it would seem more correct to consider it as a mass or bed of salt filling up a valley, than as constituting a mountain, which, according to some authors, is a league in circumference. These dimensions could only be obtained by considering the neighbouring heights as formed of this mineral, which does not appear to be the case.

The surfaces of the salt precipice, which have been long exposed to the weather, are not smooth, but cut into innumerable shallow channels, running in a tortuous manner, and divided from each other by thin edges, often so sharp as to cut the hands like broken glass. The channeled surface is evidently produced by the action of the winter rains, which have given the whole a striking resemblance to the surface of a mass of ice which had been partially thawed and again frozen. The general colour of the exposed surface is greyish white, with here and there a tinge of pale reddish brown from the colouring matter of the clay. Towards the extremities of the mass of salt, extremely thin layers of a pure and plastic clay are insinuated between the layers of salt, giving it a waved appearance. The general mass of salt is,

however, of the greatest purity; and it requires no other process than grinding, to convert it into snow-white culinary salt. The greyish hue of the external surface is owing to the rain penetrating a portion of the salt, and, by diminishing its opacity, depriving it of the whiteness which the fresh fracture generally presents. At the period of Dr. Traill's visit, the surface of this immense mass was perfectly dry, and in some places where water had most recently flowed, was covered with a snow-white efflorescence.

A perennial brine-spring flows at the foot of the great precipice, and affords a strong proof of the little effect of water on this compact salt. The aperture through which the stream has issued for many years, is not wider, externally, than two feet, and suddenly contracts to a few inches; while the channel worn in a solid floor of salt, through which the stream has long flowed, is not a foot in depth. This is partly to be ascribed to the fact that the water is saturated with salt; but during the rainy season the stream is much augmented, and thus cannot be so highly charged with saline matter. These waters flow into the Cardonero, leaving in the valley a thick scaly

crust of salt resembling the ice formed around our brooks in winter. During the rainy season, it is asserted that the salt water flowing into the river kills all the fish. At Mauresa, about twenty miles below Cardona, the water of the river contains a large portion of salt, derived from the brine-spring at Cardona. This spring is so intensely saline, that after dipping the hand into it, and exposing it to the air, it becomes instantly covered with a film of salt. The salt rock, near its source, is most elegantly veined with delicate waved delineations of an ochre yellow colour. No gypsum has been discovered in the neighbourhood of Cardona.

The salt is raised in considerable tabular masses. The part of the quarry at present wrought presents an extensive horizontal floor of pure rock-salt, the level of which is a little lower than the foot of the great salt precipice. An enormous mass of rock-salt lies between this precipice and the present working, the removal of which will, in time, render the appearance of this interesting spot still more magnificent; for then the vast front of the rock-salt bed will at once strike the eye from the lowest part of the mine.

Dr. Traill describes the mines of Cardona as being in a languid state, like every other public work in Spain. About a hundred miners were employed in quarrying the salt, and wheeling it to the receiving-house. Over these were eight overseers, who did duty in rotation, and ten sentinels were always stationed round the mine to defend it from the depredations of the peasantry. Several clerks were employed in an office at the entrance to the mine, and the whole was under the direction of an inspector, who wore the uniform of an officer in the Spanish army, for the mine is the property of the crown, and is rigidly guarded. The peasantry, however, frequently attempt to deceive the vigilance of the sentinels. When detected, the usual punishment is, even for the first offence, two or three years labour in some of the public works of the province. A soldier, however, is far less severely punished for a like offence, he being generally sentenced to a few days solitary confinement in a dungeon of the castle. The reason assigned for this disproportion in the punishment of different offenders is, that a soldier's poverty was supposed to extenuate his crime; while the peasant of Catalonia enjoyed

comparative wealth, and could afford to purchase salt. Such is the boldness of the smugglers and the jealousy of the government that it is dangerous to visit the mines without formal leave, as the sentinels have orders to fire on any one seen loitering about them.

The mills for grinding the salt are similar to our common water-mills. In its ground state it forms excellent culinary salt, of snowy whiteness. In this state it is sold to the peasantry of the surrounding districts at the rate of 7*s.* 6*d.* for 5 arrobas, or about 130lbs. The salt is carried from Cardona on mules or asses, the only beasts of burden that could travel in safety the rugged defiles of this district. Dr. Traill remarks that it seems a part of the perverse policy of the Spanish government to discourage the formation of proper roads, lest it should facilitate the operations of the smuggler. "It would not be difficult," he says, "to connect Cardona by means of a canal with the ocean, and thus the valuable produce of its salt mines might increase the revenues of the crown and the trade of Barcelona. The channels of the Cardonero and Lobregat always contain a large body of water, and might easily be

rendered subservient to the purposes of inland navigation. Besides augmenting the value of the mines of Cardona, such a plan, by facilitating the intercourse with the interior of this fine province, would stimulate the exertions of a people who only require an equitable government to become highly industrious."*

SALT ROCK AT CARDONA.

A writer who has recently visited this mine describes it as an absolute mountain of salt emerging

* Transactions of the Geological Society, vol. iii.

in a jagged outline nearly 500 feet high. "The salt pinnacles shoot forth from a brownish earth, like a quarry of marble dislocated by gunpowder. They are inexhaustible, and are admirably adapted to the indolent owners, as requiring no other labour beyond taking what Providence has prepared in its perfect chemistry. The colours of these saline glaciers vary extremely, and are brilliant in proportion as the weather is clear. When the sun shines they look like stalactites turned upside down, and are quite prismatic, with rainbow tints, and reds, and blues. It is a Sinbad-valley of precious stones. Some of the grottos look like fairy cells, lined as it were with preserved fruit sparkling with crystallized sugar. There is a peculiar mixed colour which is called *arlequino*. The traveller should visit the *furad-mico*, (the hole of the squirrel,) which is said to be a mile in depth. The miners make little articles of this salt, as is done with the fluor spars, in Derbyshire. These, in the dry air of Spain, never liquefy, which they do at once on being brought to damp England."*

Of all the countries of Asia, Persia is probably

* Ford: Handbook for Travellers in Spain.

the most abundantly supplied with salt. In this country it covers vast tracts, and occurs every where in great abundance. All the lakes are salt, and every considerable collection of water is impregnated with it. Salt mines are also found in different parts. At Nishapore, in the north, is a salt mine consisting of three excavations, in each of which a vein of salt is found from six to eighteen inches in thickness. The salt is beautifully white, and so clear that Mr. Fraser could see distinctly through a mass two inches in thickness as through a pane of glass. The mine pays a small rent, and the salt is highly esteemed throughout the country.

The salt deserts which occur in various parts of Persia form one of the most striking objects of its scenery, and may be distinguished from the general dreariness of the country by a saline efflorescence which is seen glistening in the rays of a fierce sun. This appearance extending over an immense plain, varied by a black rock here and there protruding from its surface, its image contorted into a thousand wild and varying shapes by the effect of the mirage, which produces the most curious optical illusions on those wide extended

level tracks, is a sure indication of the desolation which reigns around. The most remarkable of these salt deserts is that which extends northward from Helmund, the Elymander of the ancients, a river which takes its rise to the north of Cabul, in the range of hills that divide the country of Beloochistan from Lower Mekran, a distance of about 400 miles. In breadth, from Nooksy north-west to Jalk, it is nearly 200 miles. There are also extensive salt deserts in the provinces of Fars and Kerman, so that a large portion of the very heart of the country is desolate; and another great salt desert extends north-east from the western limit of Khorassan along the provinces of Kashan and Ispahan, and continuous with the desert of Fars, Kerman, and Seistan; several mountainous projections, however, and cultivated tracts intervening. This desert occupies a great space in the centre of the country; it extends north-east from the provinces of Ispahan and Fars, as far as Tubbus, and with somewhat more frequent interruptions to Toorsheez; and in the east it is encroached on by projections from the more cultivated districts of Furrah, Subsawur and Herat.

The appearance of these deserts is not altogether

uniform. In some places the surface is dry, and produces plants which thrive in a salt soil: in others the saline efflorescence is seen in a crackling crust of dry earth. Marshes occupy a considerable portion of the country, and in the lower parts, water accumulates during the winter months, which is evaporated, either totally or partially, in the hot weather, leaving a quantity of salt in cakes upon a bed of mud. In some places the soil is a perfectly hard-baked and barren clay, and in others again sand abounds. This is formed into hillocks in the shape of waves by the wind, and is so light and impalpable that it is blown aloft in clouds, as in the Arabian deserts, by the violent north-west winds, which prevail in summer, and proves dangerous as well as disagreeable to travellers, who are not unfrequently buried in its heaps.*

In travelling over these wide plains, Mr. Fraser was often deceived in his estimation of distances; and this was even more remarkable than it is upon water, there being so few objects wherewith to measure space, the eye is bewildered and quite put to fault. "I remember upon looking from

* Fraser's Narrative of a Journey into Khorasan.

the caravanserai at Morchacoor, from whence points in the vicinity of the next stage (Soo) are to be seen, I should have judged a small water reservoir on the road to be but two miles distant; it was twelve in reality; and a small knob upon the shoulder of a hill somewhat further, (four miles, I should have said,) turned out to be twenty. On leaving the caravanserai at Muxoodbeggee, we clearly discerned the walls of Komaishah, elevated by refraction; and though the real distance was full twenty-five miles, it did not appear to be five; instances even more remarkable, particularly when looking from a height, might be quoted. This deception has a more unpleasant effect than can be conceived; for the weariness of the body and mind, harassed by the dull unvarying scene, is exasperated by prolonged disappointment; as the same objects never altering in size or propinquity seem to the jaded traveller to recede rather than advance as he slowly winds along."

It is impossible also to conceive the effects of the mirage, and the extent to which they prevail upon the wide and level plains of these countries, where the air in a state of rapid undulation causes every object near the surface to tremble

into forms as uncertain and evanescent as the eddies that produce them. "A distant mountain in the space of a minute will assume, perhaps, first the form of a lofty peak; this, after rising to what appears a prodigious elevation, will thicken at the top and spread into that of a large mushroom with a slender stalk: the top will then split into several spires, and then all will join into a solid table shape. This is extremely puzzling to a surveyor, who depends upon the peaks of mountains as objects from which to form his triangles; for he may be thrown many degrees out of the true line by trusting to an observation under such circumstances. In other instances a mud bank, furrowed by the rain, will exhibit the appearance of a magnificent city, with columns, domes, minarets, and pyramids, all of which flit as you approach; till to your utter confusion they dwindle into a heap of earth, perhaps not ten feet high. Numberless have been the mistakes made of asses with boys on them for elephants and giants, or well mounted troops of cavalry; sheep and goats for camels and dromedaries, and the smallest bushes for fine forest trees. There is sometimes great beauty and much that is amusing in the variety of

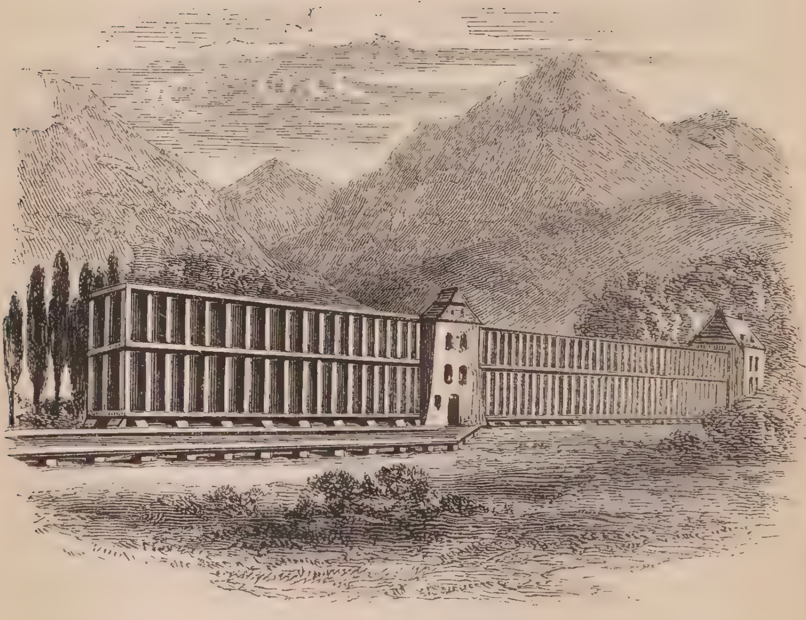
phenomena produced, but they not unfrequently involve the weary traveller in great disappointment."

The island of Ormus, or Hormuz, at the entrance of the Persian Gulf, is a barren rock without vegetation, but abounding with salt. The rugged hills which line the eastern shores are covered for a considerable distance from their base with an incrustation of salt, which in some places is as transparent as ice.

In Africa, rock-salt is abundant in the eastern part of the Sahara, or Great Desert. At Tegazza, and some other places, it lies in extensive strata under a bed of rock, and is whiter than the purest marble.

The salt plain of Abyssinia also forms an enormous deposit. This plain is situated near the country of the Assa Durwa, about fifty miles west of Amphila, on the road to Massowa. It is about four days' journey in extent from north-east to south-west, and persons crossing it wear sandals made of the leaves of a species of palm. The plain is perfectly flat. For the first half-mile the salt is soft; it then becomes hard and crystalline, like ice on which snow has fallen after it has been partially thawed. Branches of pure salt occasionally

rise above the surface. The salt is cut with an adze into pieces the shape of a whetstone. Immediately under the surface, to the depth of about two feet, it is hard and pure; then it becomes coarse and softer until it has been exposed to the air. The employment of cutting the salt is very dangerous on account of the hostile tribe of Galla, who frequently attack the workmen. None, therefore, are employed except the lowest order of natives, who lie down on their backs, or flee to the mountains, on the approach of the Galla. Salt caravans, called *cafilas*, are regularly sent for salt from Antalo, and the situation of Balgudda, or protector of these caravans, is of great importance as well as emolument; for on their safe arrival mainly depends the internal and external commerce of the Abyssinians. When they arrive, therefore, they are received with acclamation and joy. These caravans are frequently attacked by the Galla. The pay of the Balgudda is derived from the duty imposed on the importation of salt. A camel, the usual load of which is 200 pieces, pays eleven; a mule, carrying eighty, pays nine; an ass pays six. These pieces of salt are used in Abyssinia as money.



THORN-HOUSE AT MOUTIERS.

CHAPTER IV.

SPRINGS OF WEAK BRINE IN INLAND DISTRICTS—ECONOMICAL METHOD OF OBTAINING SALT—METHOD PRACTISED IN SARDINIA—THORN-WALLS—ROPE-HOUSES—METHOD ADOPTED IN SAXONY—LOSS OF SALT BY EVAPORATION—SALT DEW—BOILING THE BRINE—MARINE PLANTS AND ANIMALS NEAR SALT WORKS—SALT SPRINGS OF TUSCANY.

WHEN a spring during its course comes in contact with a bed of rock-salt, a natural brine well is formed as already noticed. These wells are seldom so highly saturated as the artificial springs formed by letting fresh water down through a bore to the middle of the salt-bed, and pumping it up again as a saturated solution. Natural salt-wells are usually very slightly impregnated, or they have become weakened by mingling with fresh water after leaving the salt-bed; yet, in many inland situations, where the cost of carriage would make salt a very expensive article, it is found profitable to boil down the weak brine of these springs for the purpose of obtaining salt.

In such cases, however, an abundant supply of cheap fuel must be at hand; and even then it would be too costly to conduct the process entirely by means of artificial heat. The greater portion of the water is, therefore, first removed by evaporation in the open air, and the smaller portion of the water is got rid of by boiling.

Now, as the rate at which evaporation proceeds depends upon the amount of surface exposed to the open air, an ingenious contrivance is resorted to in Savoy and Germany, by which the weak brine is exposed to the air in the form of rain, and the action of the air is increased by retarding the single drops as they fall. This plan was first introduced at Moutiers, the capital of the province of Tarentaise, in Sardinia, in the year 1550, for the purpose of obtaining a more economical supply of salt from the neighbouring brine springs of Salins. The plan was first described in England by Mr. Bakewell,* from whose account the following particulars are derived.

The salt works at Moutiers are conducted with remarkable economy, and produce nearly three million pounds of salt from a source of water

* Travels in the Tarentaise. 1823.

which would scarcely be noticed except for medicinal purposes in any other country. The springs that supply the salt works, rise at the bottom of a nearly perpendicular rock of limestone, situated on the south side of a deep valley or gorge, through which the Doron runs before it joins the Isere. The distance from the springs to the salt works is about a mile; the water runs in an open canal made for the purpose, but is received in a reservoir in its passage where it deposits part of its ochreous contents, and the canal along which it runs is also lined with a red ochreous incrustation. The water rises from the rock with considerable force, and emits much gas, which is principally carbonic, with a mixture of sulphuretted hydrogen; it has an acidulous and slightly saline taste. These springs rise at the end of long passages, excavated in the rock. The temperature of the strongest spring is 99° Fahr.: it contains only 1.83 per cent. of saline matter; other sources contain only 1.50. Besides common salt, the water contains small proportions of sulphate of lime, sulphate of soda, and sulphate and muriate of magnesia, together with oxide of iron.

It may seem remarkable that these waters, which have only half the strength of sea-water, should repay the expense of evaporation. It is obvious that water so weakly impregnated with salt as to contain only one pound and a half in every thirteen gallons, could not repay the expense of evaporating by fuel in any country. In order to make salt from this saline water, it was necessary to concentrate it by natural evaporation, and to effect this speedily it was required to spread the surface of the fluid over as large a space as possible, the rate of evaporation being in proportion to the extent of surface exposed to the action of the atmosphere. The first attempt at Moutiers was made in 1550, by arranging pyramids of rye-straw in open galleries, and letting the water trickle through them gradually and repeatedly. By this process a portion of the sulphate of lime was deposited on the straw, and the water became concentrated to a certain degree. It was then carried to the boiler and further evaporated by fuel. In 1730, the present buildings were erected. There are four evaporating houses, called *Maisons d'Epines*, or *thorn-houses*. Nos. 1 and 2 receive the water from the reservoir, and concentrate it to

about 3° of strength, that is, they evaporate one half of the water they receive. These houses of evaporation are each three hundred and fifty yards in length, about twenty-five feet in height, and seven feet wide. They are uncovered at the top. They consist of a frame of wood, composed of upright posts, two and a half feet from each other, ranging on each side, and strengthened by bars across: the whole is supported on stone buttresses about three feet from the ground, under which are the troughs for the salt water to fall into. The frame is filled with double rows of fagots of black thorn, ranged from one end to the other up to the top; they are placed loosely so as to admit the air, and supported firmly in their position by transverse pieces of wood. In the middle of each *Maison d'Epines* is a stone building containing the hydraulic machine for pumping the water to the top of the building; it is moved by a water-wheel. When the water is raised to the top it is received in channels on each side, which extend the whole length of the building; from these long channels it is made to pass into smaller ones by the side, from which it trickles through a multitude of small holes, like a very gentle shower, upon the

fagots, where it is divided into an infinite number of drops falling from one point to another. Being thus exposed to the contact of the air, it gains one degree of strength in falling, and by the action of the pumps it is raised again, and falls in other showers, till it has acquired the strength adapted to its passing to the evaporating house No. 2.*

The process is conducted with less nicety in Nos. 1 and 2 than in the others. The pumps are distributed at equal distances on each side of the thorn wall, and are worked by the machine in the centre of the building. The water is not allowed to trickle down on both sides of the thorns, but only on that exposed to the wind. The two buildings, Nos. 1 and 2, are placed at different angles, to catch the different currents of wind that rush down the valley. No. 3 is constructed on the same principles as Nos. 1 and 2; it receives

* Mr. Bakewell remarks that this mode of evaporation by the use of fagots was long misunderstood; that it has often been stated by English writers, and has recently been again gravely repeated, that it consists in throwing salt water upon burning fagots, and gathering the salt that remained. This would be a mode of making salt as wise and practicable as the nursery method of catching birds by putting salt on their tails.

the water from them both; it is 370 yards long, and is covered to preserve the salt water from the rain. There are twelve pumps on each side of this building, and more care is taken to distribute the water equally: here it is concentrated to the strength of 12 per cent. and deposits most of its remaining sulphate of lime in incrustations on the twigs.

The water being now reduced to about one-seventh of the original quantity, is passed along channels to the thorn-house No. 4. This is only seventy yards in length; here it is further concentrated by a similar process till it nearly reaches the point of saturation, but this depends on the season. In dry weather it is raised to 22°, but in rainy moist weather to 18° only. In summer-time, the whole process of evaporation in passing through the different houses, is about one month; in wet seasons it is longer. The stream of water that sets in motion the hydraulic machines for raising the saline water to the top of the building, is brought by a small aqueduct from the river Doron. When once in motion the process goes on and requires little further attention or manual labour till it is completed. When the water is

nearly saturated it passes to a large building containing the pans for boiling, and the salt is crystallized in the usual method. The following statement will convey an idea of the quantity of water evaporated before it comes to the pans:—

8,000 hogsheads when received at the evaporating houses, Nos. 1 and 2, contain about $1\frac{1}{2}$ per cent. of salt, and are reduced by evaporation to 4,000 hogsheads.

4,000 hogsheads when received at No. 3 contain about 3 per cent. of salt, and are reduced to 1,000 hogsheads.

1,000 hogsheads when received at No. 4 contain about 12 per cent. of salt, and are reduced to 550 hogsheads.

550 hogsheads received at the pans contain nearly 22 per cent. of salt.

Thus, out of every 8,000 hogsheads passing through the evaporating houses, 7,450 are evaporated by the air in summer, and about 7,000 in winter; and only one-sixteenth part of the fuel is consumed that would be required for evaporating the whole quantity of water by fire.

The fagots are changed at periods of from four to seven years. Those in Nos. 1 and 2,

where the saline impregnation is weak, will decay sooner than in Nos. 3 and 4. In No. 3 all the twigs acquire so thick a coating of sulphate of lime, that, when broken off, they resemble stems and branches of encrinites.

In the covered house, No. 3, there are twenty-four pumps—twelve on each side—to distribute the water more equally over the whole. This system of pumps is worked by joined bars of wood, which move backwards and forwards, and are connected by crank-wheels with each piston, to raise and depress it. It has been already mentioned, that care is taken to evaporate on the windward side of the building. When Mr. Bakewell was on the top of No. 3, though the air was very warm, he felt an intense degree of cold, in consequence of the speedy evaporation.

The total length of the *Maisons d'Epines* is as follows:—

Nos. 1 and 2 together	700	English	yards.
No. 3	370	"	"
No. 4	70	"	"
Total	1,140, or nearly two-thirds of a mile.		

The fuel used at the pans for the last process is partly wood and partly anthracite, from the

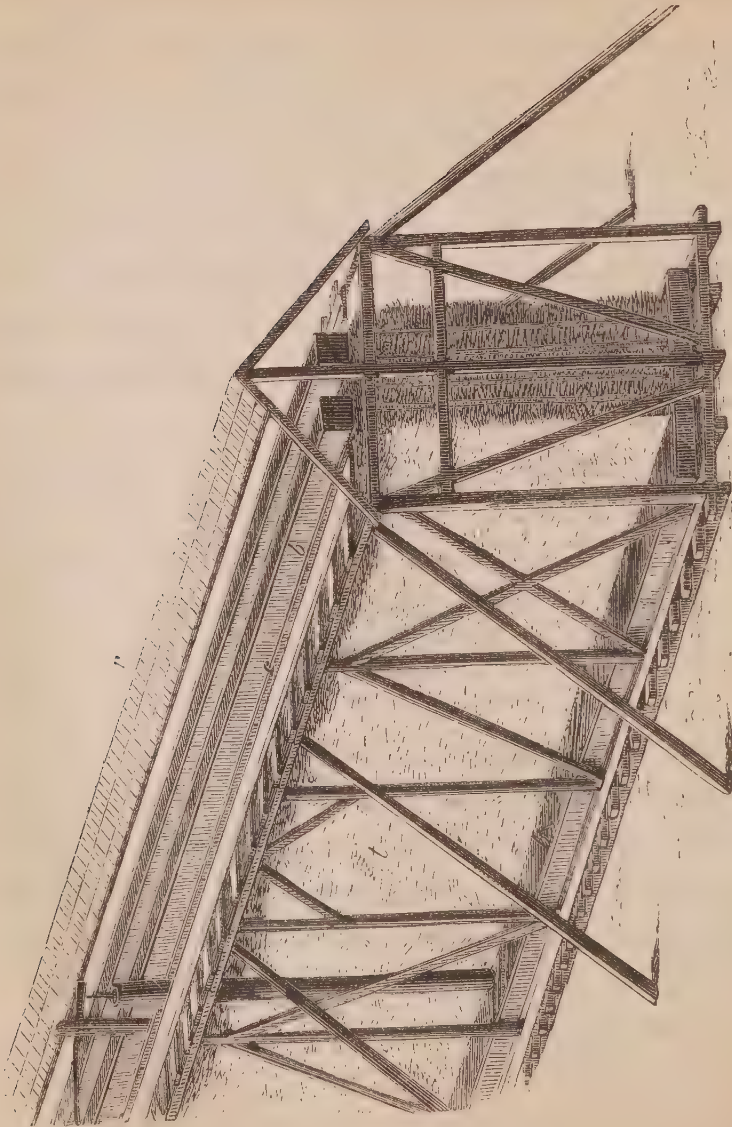
neighbouring mountains. The anthracite answers remarkably well when once ignited, as it preserves, for a long time, a regular degree of heat. The consumption of wood was formerly so great, that it has stripped many of the higher mountains in the Tarantaise, and exposed them to the action of the atmosphere, which has occasioned vast eboulements, or mountain slips; for it is found that forests are of the greatest utility in preserving mountains from destruction. The fact is now so well ascertained, that the Government, for this cause alone, have paid particular attention to the preservation of the wood. The quantity of salt made annually at Moutiers is estimated at about 2,250,000 lbs., and about 187,000 lbs. of sulphate of soda. The other alkaline matter which adheres to the pans is sold to the glass-makers. The Government receives on the average 150,000 francs for the products, out of which it is estimated that 30,000 are expended for wood and fuel, 8,000 for materials employed in the buildings, and for the fagots, &c., and 62,000 for the wages of the different officers; leaving an annual profit of 50,000 francs.

Brine springs are met with at a few places in Saxony; but as they are only slightly impregnated

with salt, evaporation by means of fuel would be far too costly a method of obtaining this necessary article of food from them. The method of graduation adopted at Moutiers was introduced into Saxony in the year 1559; and as the plan has, from time to time, received the attention of scientific chemists, it has, in many respects, been improved. We may, therefore, be allowed to introduce a few more details on this interesting subject.

At the Saxon salt-works, the brine is pumped up into a large reservoir, generally placed in a tower, from which it flows into the troughs of the thorn-house. A number of horizontal pipes convey the brine from these troughs in a thin stream to a perforated channel *c*, from which it falls, drop by drop, upon the wall of blackthorn fagots *t*. A sloping board prevents the wind which passes through the thorns from giving a wrong direction to the falling drops, and the whole is covered with a roof *r*, to prevent rain-water from mingling with the brine.* That the air may exert its full effect, the whole structure is erected in an airy situation,

* In the engraving, the greater portion of the roof is removed.



and in a direction at right angles to that of the prevailing wind. If the wind changes, and threatens to carry the brine away from the wall, the graduation is reversed to the opposite surface of the thorn-wall, and this is done by moving a lever, whereby certain channels are closed, and others opened, and the brine is carried to the other side, to the opposite surface of the thorns. The brine thus slowly falling and trickling through the thorns, exposes a large surface to a constant current of air, which thus carries off in vapour a considerable portion of the pure water, and leaves the brine, which falls into the lower tank, much stronger than before. The operation is repeated from three to eight times, for which purpose, the graduation houses are divided into several compartments, the foremost of which serves for the first fall, the second for the next fall, and so on. At Schönebeck, the surface of the thorn-wall is equal to 390,000 square feet, and this evaporates on an average during the day 3 $^7/_{10}$ths cubic feet of water from each square foot of wall; or in a year of 258 working days, nearly a million and a quarter hogsheads of water. The pumps which serve to raise the brine are usually situated in the

central part of the works, and are commonly worked by a hydraulic wheel, as at Moutiers.

Previous to the introduction of this plan into Saxony, the graduation was effected by distributing the brine over flat inclined wooden surfaces, or over ropes, stretched backwards and forwards in lengths of many thousand feet. This method is still in use at Moutiers, in addition to the plan already noticed; and during the whole summer, salt was formerly crystallized solely by graduation, without any evaporation by fire. The *Maison de Cordes*, or *rope-house*, was invented by an ingenious Savoyard, named Buttel. It is forty yards in length, and eleven wide: it is much stronger than the *Maison d'Epines*, the roof being supported by six arches of stone work; the intermediate spaces on the sides being left open. In every one of these divisions are 1,200 cords in rows of twenty-four each, suspended from the roof, and fixed tight at the bottom. The cords are about sixteen feet in length. The water is raised to a reservoir at the top of the building, and distributed in a number of small transverse canals, each row of twenty-four cords having one of these canals over it, which is so pierced as to admit the water to

trickle down each separate cord drop by drop. The original intention of this building was to crystallize the salt itself upon the cords; for which purpose the water was made use of from the pans, after it had deposited a quantity of salt in the first boiling, to save the expense of fuel in a second boiling;—the residue-water of the first boiling, by repeatedly passing over the cords, deposited all its salt in about forty-five days, and the cords were encrusted with a cylinder of pure salt, which was broken off by an instrument adapted to the purpose. This process is at present abandoned for crystallizing; but the cords are still used for evaporating, and are found to answer better for the higher concentration of the water than the fagots. This method did not answer for the first evaporation, because the water rotted the cords; but it was discovered, that the cords were not soon injured by it when it had acquired 5° of strength. Mr. Bakewell was informed that the cords at Moutiers had many of them remained thirty years in use without being changed; indeed they were so thickly encased with depositions of gypsum as to be defended from the action of the water. This mode of evaporating is found to be more expeditious than that of the fagots.

In the *Maison de Cordes* it is found that the evaporation goes on more speedily in windy weather than in the *Maisons d'Epines*, as might be expected from the more ready access of air to the surface of the water. The cords are double, passing over horizontal rods of wood at the top and the bottom, to keep them firm in their positions, and at regular distances from each other. The cords are not thicker than the finger, but with the incrustations of sulphate of lime they are often as thick as the wrist.

But to return to the Saxon method of graduation by the use of thorn-walls. Of course the graduation proceeds best with a moderately warm wind and sunshine; a moist calm atmosphere is less favourable to it, and in rainy weather the process is suspended. Very strong winds also occasion inconvenience, by carrying off the brine. Frost is also injurious; for Berzelius has observed, that below 27° Fahr. sulphate of magnesia, with a portion of chloride of sodium, becomes converted into chloride of magnesium and Glauber's salt; and that this decomposition is not reversed when the weather becomes warmer. Salt is therefore not only lost in this manner, but the quantity of chloride of magnesium is increased, which is inju-

rious in the boiling process. Graduation is therefore limited to the most favourable portion of the year, including about from 200 to 260 days. It is necessary to regulate the flow of the brine according to the force of the wind; but even with this precaution, there is always considerable loss, from the blowing away of the smaller drops, and also from salt evaporating with the water. That a portion of the salt does evaporate with the water has been proved at the salt works of Nauheim, where the director, M. Wilhelmi, placed a plate of glass upon a tall pole between two evaporating houses, distant about 1,200 paces from each other, and it was found in the morning, after the drying of the dew, that the glass was covered with crystals of salt on one or the other side, according to the direction of the wind.*

In the course of time, the thorns over which the brine trickles become covered with a thick coating of *thorn-stone*, as it is called, consisting of carbonates

* Pallas remarked, so long ago as 1770, that in the neighbourhood of the salt lakes of Asiatic Russia, the dew was salt to the taste, and not only the dew which was deposited on plants, but that which collected on smooth surfaces, and even on the dress of persons exposed to it. See the German edition of his Travels, vol. i. p. 426, and vol. iii. p. 635.

of lime, magnesia, manganese, and iron, with traces of chlorides. As these deposits gradually fill up the interstices of the thorn-wall, and stop the draught of air, it is necessary to renew the wall every five, six, or eight years. In the brine-cisterns a similar deposit forms like a fine mud, sometimes accompanied by a greyish, thick, scum-like mass, filled with bubbles; this is almost entirely composed of living infusoria, evolving large quantities of pure oxygen.

The progressive evaporation of the water, although varying with the nature of the locality and the state of the weather, may be seen from the following statement, which refers to Dürrenberg.

One cubic foot of brine contains—

In the beginning	2.5 lbs.	of salt.
After the first graduation . . .	3.9	,,
After the second	5.6	,,
After the third	8.	,,

100 lbs. of salt are therefore dissolved,

In the beginning . . .	in 38.3	cubic feet	of water.
After the first graduation.	,, 24.7	,,	,,
After the second . . .	,, 16.6	,,	,,
After the third	,, 11.3	,,	,,

For every 100 lbs. of salt are therefore evaporated,

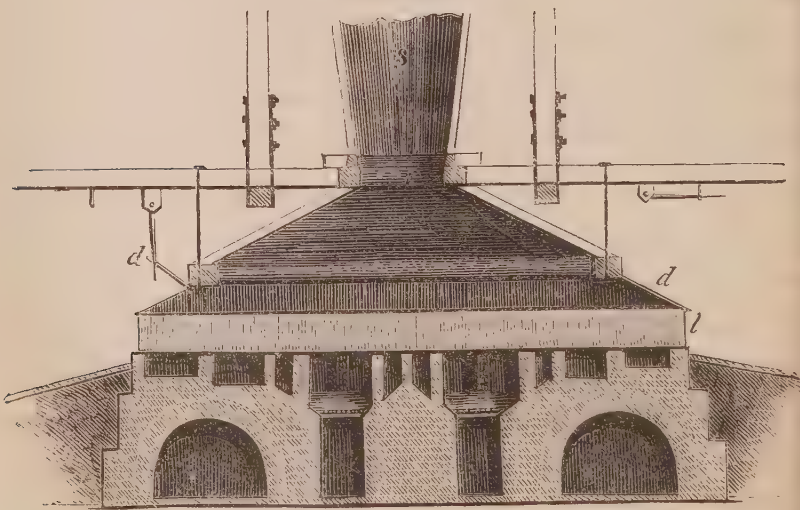
In the first graduation	13.6 cubic feet.
In the second	8.1 „
In the third	5.3 „

As the evaporation diminishes the loss in graduation increases with the strength of the brine, and, at length, a period arrives when the loss of salt by the wind is equal to the advantage of further evaporation of water. The brine is generally considered fit for boiling when it contains 23 per cent. of salt. If the natural spring contains as much as this, as is the case in some places, the brine is boiled down at once without being graduated.

The brine which is graduated during the fine season, is stored up in vast reservoirs of masonry, covered over and protected from frost. Here the brine makes a further deposit of matters suspended in it. From these reservoirs the pans in the boiling-houses are supplied. The boiling is carried on during the winter months only. Each pan in which the boiling is conducted is a flat four-sided vessel of sheet iron, with a flat bottom, somewhat deepened towards the middle. Some of these pans are as much as sixty feet in length, and thirty in width.

The bottom is supported by brick-work, which contains the flues which are arranged so as to

distribute the flame of two separate fires as uniformly as possible; the flues are also made to heat the chambers where the salt is dried. In order that evaporation may proceed rapidly in the pans, it is necessary for the air to circulate freely above the surface of the liquid. For this purpose each pan is covered with a roof-shaped hood of boards, into which descends a steam or vapour trunk *s*, furnished at the bottom with a number of wooden shutters *d d*, which can be turned



back or closed as occasion may require. The external air thus passes in a constant current over the surface of the brine, and becoming saturated

with vapour, escapes into the chimney. As this vapour contains about one per cent. of salt, means are taken for collecting that portion of it, which becomes condensed and trickles down the sides of the chimney. This is done by placing near the bottom of the chimney, a sort of channel connected with a tube *t* leading into a tank. The process of boiling consists of two distinct operations: first, the *schlotage*, or the further purification and evaporation of the brine, up to the point of saturation; secondly, the *soccage*, or crystallization of the salt.

The pans are rather more than half filled (up to *l*) with clear brine from the reservoirs, and raised rapidly to the boiling point, the portion which escapes as vapour being replaced from time to time by fresh brine. The surface soon becomes covered with a dirty brown scum, which, with various salts, forms a thick mud. This is partially removed by means of rakes, but a quantity collects on the bottom of the pans, forming what is called *pan-scale*. After twelve or fifteen boilings it increases often to the thickness of an inch, and must then be broken up with chisels before it can be removed. The salts in the deposit are chiefly gypsum and sulphate of soda, with a quantity of

chloride of sodium; so that these deposits occasion a loss of salt during the boiling.

In the mean time, the solution of salt becomes more concentrated by the constant evaporation and renewal of the brine, until, at last, it crystallizes. A pan containing 1,600 cubic feet of brine, or 176 cwt. of salt, being refilled as often as one-fourth of the quantity is evaporated, the quantity of salt in the pan after the first addition will be

$176 + \frac{176}{4} = 221$ lbs.; after the second addition

$176 + 2\frac{176}{4} = 286$ lbs. and so on. When, therefore, at the end of twenty or twenty-four hours, a pellicle of crystals begins to form over the surface, the fire is diminished until the temperature of the brine is allowed to fall to 194° Fahr. and from that to 167°, when, with slow evaporation, the soccage begins and lasts for several days, during which time the small floating crystals on the surface gradually form into four-sided funnels, and soon sink to the bottom by the agitation caused by the escaping vapour. When the pan is kept at a high temperature the crystals have no time to increase in size, and salt of a finer grain falls to the bottom.

At the lowest possible temperature they remain floating a longer time, and produce salt of coarse grain. In the former case the process is rapid, in the latter more slow. But neither the process nor the temperature of the soccage are entirely at the command of the workmen, because the chloride of magnesium is always a source of obstruction when little or no sulphate of soda is present. Then two salts mutually decompose each other in the pan, giving rise to chloride of sodium and sulphate of magnesia.

It was observed with the brine from Rodenberg, that the more concentrated brine which contained chloride of magnesium, but no sulphate of soda, became constantly covered all over its surface, at the ordinary temperature of soccage, with a continuous scum of salt which the vapours could neither break up nor pass through, and when removed it was immediately formed again, and thus prevented evaporation from going on. Thus no coarse-grained salt could be produced, and the evil could only be remedied by reducing the temperature, which occasioned loss of time. A remedy was found for the evil by mixing the weaker brine, which contains sulphate of soda but

not chloride of magnesium, with the former; but the mixture thus produced contains these two salts, which mutually decompose each other, and produce chloride of sodium and sulphate of magnesia. The result was the same when sulphate of soda was added at once without diluting the brine by adding this salt in solution. During Sunday, when all work is stopped, *Sunday-salt* is produced by large crystals forming at the bottom; for the salt not being quite so soluble in cold as in hot brine, a portion begins to crystallize as soon as the temperature is lowered, and this attaches itself to the other crystals already in the pan.

The purity of the salt gradually diminishes towards the end of the process. Thus Berthier found in the salt of Moutiers:

	Salt.	Chloride of Magnesium.	Gypsum.	Sulphate of Magnesia.	Sulphate of Soda.
At the beginning .	94.64	—	1.56	—	3.80
In the middle . .	93.59	0.61	—	0.25	5.55
Towards the end .	85.5	2.0	—	12.5	—

For this reason the soccage must be stopped before all the salt is deposited.

During the whole process of soccage, the salt is raked up from the bottom with long rakes to the

edge of the pan, and placed either in wicker baskets of peeled willow, or heaped upon the boards *dd*, which are thrown back for the purpose, and in either case, the brine which drains from the salt is allowed to flow back into the pan.

The moist salt which remains is conveyed to the drying room, either in the same willow baskets, or it is spread out upon hurdles, and allowed to remain so long as it loses moisture. It is then packed up for sale.

The salt thus produced is never entirely pure chloride of sodium. It is frequently contaminated with a minute portion of one or other of the following salts:—Chloride of magnesium, chloride of calcium, sulphate of soda, (Glauber's salts,) sulphate of magnesia, (Epsom salts,) sulphate of lime (gypsum). Of all these salts, the chloride of magnesium has the greatest influence on the quality of the produce, on account of its deliquescence in the air and its highly saline taste. Pure chloride of sodium never attracts moisture from the air; but, when containing only a minute portion of chloride of magnesium, it soon becomes wet in damp weather. Such salt, however, is usually preferred to the purer kinds in places where salt is ex-

pensive; because, on account of its pungent taste a much smaller quantity is consumed. The chloride of magnesium can be got rid of during the soccage by adding slacked lime to the brine in the pan.

After each soccage a quantity of impure brine is left in the pan, which, however, is not rejected after every process. A second, and sometimes a third charge is boiled down before the residue (the *mother-liquor*) is removed. This is a viscous, odoriferous fluid, and may contain the chlorides of calcium, magnesium, potassium, and sodium; the sulphates of magnesia and of lime, and a trace of bromides and iodides. Epsom and Glauber's salts are extensively manufactured from this source, which also furnishes a supply of pure bromine and iodine.*

It is an interesting fact, that the plants which generally grow on the sea-shore, such as the *triglochinum maritimum*, the *salicornia*, the *salsola kali*, the *aster trifolium*, or Farewell-to-summer, *glaux maritima*, &c., occur also in the neighbour-

* For many of the foregoing particulars respecting the manufacture of salt in Germany the writer is indebted to Knapp's Technology, vol. i., translated by Dr. Ronalds, &c.

hood of salt-mines and salt-springs. And the reason for this is that in such situations they find the food adapted to their habits. "It is thought very remarkable," says Liebig, "that the plants of the grass tribe fitted for the food of man follow him like the domestic animals. But saline plants seek the sea-shore or saline springs, and the chenopodium the dung-hill from similar causes. Saline plants require common salt, and the plants growing only on dunghills need ammonia and nitrates, and they are attracted to places where these can be found, just as the dung-fly is to animal excrements. So, likewise, none of our corn-plants can bear perfect seeds; that is, seeds yielding flower without a large supply of phosphate of magnesia and ammonia, substances which they require for their maturity. And hence, these plants grow only in a soil where these three constituents are found combined, and no soil is richer in them than those where men and animals dwell together: where the manure furnished by these is found, corn plants appear, because their seeds cannot attain maturity unless supplied with the constituents found in such manure. When we find sea plants near our salt works, several hundred miles distant from the

sea, we know that their seeds have been carried there in a very natural manner, namely, by wind or by birds, which have spread them over the whole surface of the earth, although they grow only in those places in which they find the conditions essential to their life.

"Numerous small fish, of not more than two inches in length, (*Gasterostens aculeatus*,) are found in the salt pans of the graduating house at Nidda, a village in Hesse Darmstadt. No living animal is found in the salt-pans of Neuheim, situated about eighteen miles from Nidda, but the water there contains so much carbonic acid and lime that the walls of the graduating house are covered with stalactites. Hence the eggs conveyed to this place, by whatever cause, do not find the conditions necessary for their development, although they did so in the former place."

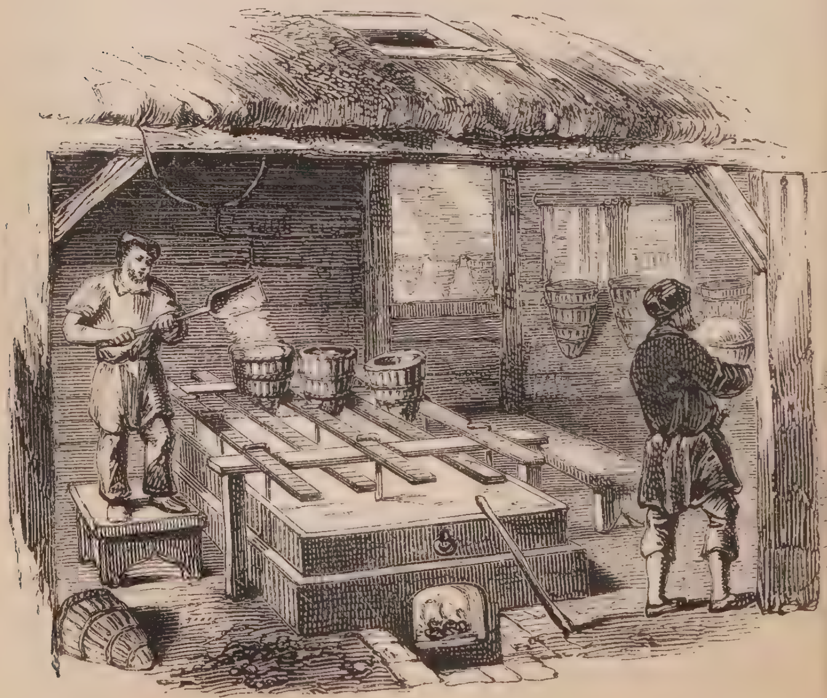
In the Grand Duchy of Tuscany salt is manufactured from brine springs. The royal manufacture has its principal direction at Volterra, and its dependencies at a short distance from that city, bearing the name of the salt-works of St. Peter, St. Lawrence, and St. Leopold. The last are the most modern, the most extensive and complete,

and in these the administration seeks to concentrate its operations. The territory in the neighbourhood is rich in natural springs of salt waters, and by means of pumping machines these waters are conveyed to the appropriate receptacles. The water is then evaporated in boilers, and a salt of exceedingly fine grain is obtained, which is passed to the ovens and dried before it is transferred to the warehouse. The average annual demand for the years ending 1834 has been 17,898,229 lbs. of white salt; and the consumption of fuel was 153 lbs. for every 100 lbs. of salt obtained. The sale of the salt is subject to a particular administration, and a reduction of price is made when it is to be employed in salting provisions or in manufactures; though, in these cases, the marine salt of the island of Elba is more frequently used.

The warehouses of Volterra supply the rest of the Grand Duchy. The salt-works occupy on an average about ninety labourers, who are employed in raising the water from the wells, in attending to the manufacture, conveying the salt to the warehouses, cutting and transporting firewood, and keeping the roads, and other means of communication, in repair.

It was stated to Dr. Bowring, that the cost of manufacture did not exceed 1*s*. 8*d*. per cwt. "The wood, it must be remembered, costs only the expense of cutting, as it is furnished by the State forests. But I imagine salt could be imported at a lower price from foreign countries, even after the payment of freight." The government charge to the consumer is about 21*s*. per cwt.*

* Bowring: Report on the Statistics of Tuscany, &c.



CHAPTER V.

SALT-SPRINGS IN THE UNITED STATES OF AMERICA—SALT-LICKS—SALT-PLAINS — BORING SALT-WELLS — ANECDOTE—SALT-WELLS OF CHINA—METHOD OF BORING—WELLS OF INFLAMMABLE GAS USED TO EVAPORATE THE BRINE—SALT-WELL IN DURHAM—IN JAVA.

DEPOSITS of rock-salt have not hitherto been discovered in the United States of America, although their presence seems to be indicated by numerous salt-springs. In the central states these springs are very common, particularly in Arkansas, Virginia, Ohio, and Kentucky, and also in Pennsylvania and New York. Throughout North America the term *Lick* is applied to those marshy swamps where saline springs break out, and which are frequented by deer, buffalos, and other wild animals for the sake of the salt, whether dissolved in the water, or thrown down by evaporation in the summer season, so as to encrust the surface of the marsh. Cattle and wild beasts devour this incrustation greedily, and burrow in the clay impregnated with salt in order to lick the mud.

Bartram, the botanist, in 1790, visited Buffalo Lick, in Georgia, which forms part of a cane swamp, where the head branches of the Ogeechee River take their rise. The lick consisted of "white-coloured, tenacious, fattish clay, which all kinds of cattle lick into great hollows, pursuing the delicious vein. I could discover nothing saline in its taste, but an insipid sweetness. Horned cattle, horses, and deer are immoderately fond of it, insomuch that their excrement, which almost totally covers the earth to some distance round this place, appears to be perfect clay, which, when dried by the sun and air, is almost as hard as brick."

Travellers have noticed tracks in the woods, extending for hundreds of miles, formed solely by wild animals on their way to the salt licks. Where these springs are weak, and their channels consequently hidden, or lost among the obstructions of a tangled forest, the well-heads of these salt-springs are commonly discovered by the hunters, who notice the various deer-tracks leading to one point, whither these animals repair at certain seasons to browse on the salt-impregnated herbage, or to lick the pebbles at the well-head, or to lap

the water at the spring. Hence, an American hunter is always glad to discover a salt-lick, because it affords him such facilities for falling in with, and shooting down his game, as are only enjoyed by those who hunt in the vicinity of saline springs.

The celebrated bog of Kentucky is situated in a nearly level plain, in a valley bounded by gentle slopes, which lead up to table-lands, formed of blue argillaceous limestone and marl. There are two springs on the left bank of the stream which flows through the plain, and two on the opposite bank, the most western of which is called the Gum Lick. The removal of the surrounding forest has had the effect of drying up part of the morass. A few years ago wild bisons or buffalos crowded to these springs for the sake of the salt; but they have retreated before the progress of cultivation. The proprietor of the land directed the attention of Sir C. Lyell to two buffalo-paths, or trails, still extant in the woods, both leading directly to the springs. One of these, in particular, which first strikes off in a northerly direction from the Gum Lick, is afterwards traced eastward through the forest for several miles. It

was three or four yards wide, only partially overgrown with grass, and sixty years ago was as bare, hard, and well-trodden as a high-road.

The bog in the spots where the salt-springs rise, is so soft that a pole may be forced into it many yards perpendicularly. It may readily be supposed that horses, cows, and other quadrupeds, are now occasionally lost here, and that a much greater number of wild animals were mired formerly. It is well known that during great droughts in the Pampas of South America, the horses, cattle, and deer, throng to the rivers in such numbers that the foremost of the crowd are pushed into the stream by the pressure of others behind, and are sometimes carried away by thousands and drowned. In their eagerness to drink the saline waters, and lick the salt, the heavy mastodons and elephants seem, in like manner, to have pressed upon each other, and sunk in these soft quagmires of Kentucky, and, accordingly, the bones of these animals have been found in them in large numbers.*

In the northern part of the State of New York, about thirty miles north-east of Lake

* Lyell: Travels in North America. 1845.

Ontario, and nearly 300 from the Atlantic Ocean, are situated some of the most copious salt-springs that have been discovered in the United States. Salt-works are established near the town of Onandaga. Before these works were in operation, and at a time neither roads nor canals existed, salt was a scarce and dear article in all the new settlements situated to the westward. But when inland communications were opened, connecting one part of the western country with another, and those parts with the older settlements, a barrel of salt weighing 280lbs. could be purchased on the shores of Lake Huron or Michigan for 10*s*.

Near the northern sources of the Arkansas River the salt-springs are diffused over the surface of the ground, and, being dried up in the lower parts of the plains by the heat of the sun, form incrustations of considerable thickness and solidity. Thousands of bushels of salt can thus be gathered in a short time.

At Gallatin, in Illinois, the salines are abundant. In the year 1831 this place had nine furnaces at work, containing about sixty kettles, each holding from thirty-six to sixty gallons, and producing upwards of 3,000 bushels of salt per week, or

about 130,000 bushels per annum. The salt is sold at the works at from 1*s.* 6*d.* to 2*s.* a bushel of 50lbs. About one half of the salt manufactured here is exchanged for corn, meal, flour, beef, pork, potatos, and other articles. At the Big Muddy Saline, also in Illinois, is a spring rising through a well upwards of 200 feet deep, and the fountain is so strong that it gushes six feet above the surface of the ground, and in quantity sufficient to supply pans for five furnaces.

Where salt-licks are known to exist in newly-settled land the owner will sometimes expend a considerable sum of money in boring, for the purpose of getting a more copious and available supply of brine. The following is the method of boring:—Having fixed on the spot near the lick, a perpendicular hole is bored, about $2\frac{1}{4}$ inches in diameter. This is done by means of an iron auger, the end of which is faced with steel, and brought to a blunt edge. The iron is about three or four feet long, and is attached to a wooden pole, which is gradually lengthened by the addition of other poles as the work progresses. When the hole has been bored to a moderate depth, a stout upright post, with a forked top, is

firmly fixed in the ground. A long, straight pole is inserted into the fork, and is used as a lever, one end being placed directly over the hole, and is attached to the upper end of the auger. By depressing the other end the auger is raised to the height required. A small cord is then pulled, which instantly detaches the auger from the lever, so that the auger descends into the hole with considerable force. One person stands over the hole, whose duty it is to turn the borer one-third, or one-half round every time it is raised, so that a second blow may not strike in exactly the same place as the first. A second person manages the lever, and a boy pulls the cord. Where the rock is hard, this method is slow, and, as the auger requires to be occasionally changed for the purpose of sharpening, a great deal of trouble is occasioned when the boring has reached the depth of 200 or 300 feet, because all the intermediate joinings of the wooden rods have to be unfastened. If in this way a supply of brine is obtained, pipes of tinned iron or of copper are inserted into the hole as a lining, for the purpose of keeping the hole open and preventing the water of such springs as may lie between the salt-spring and

the surface from mingling with and diluting the brine.

A good deal of speculation is carried on in the United States, in "wild," or unsettled land, and many expedients are resorted to to procure a favourable character for such lands. Some are advertised as being "well-watered," or "well-timbered," or "possessing excellent mill-sites," or "containing a saline spring," &c. It is melancholy to think that these announcements are often gross deceptions, which involve the purchaser in loss or ruin. Of course, it is not easy to deceive those who have opportunities of judging for themselves; but as many of the land sales are effected at a considerable distance from the places where the lands are situated, the purchasers often become victims of the wicked frauds of the auctioneers. A writer in the Penny Magazine relates, from his own observation, a fraud respecting a salt-spring, which was practised upon a person who actually went to inspect the land offered for sale. He says,—"A tract of land in a wild state, containing 300 or 400 acres, was advertised for sale, and, among the good qualities mentioned in the advertisement, a salt-spring was prominently spoken

of. It had long been rumoured that the water of a certain small spring on the said tract was slightly impregnated with salt; but, excepting the owner of the property, I never met with any one that appeared convinced that such was really the case; and many, like myself, had tasted the water at the well-head, (for the owner had caused a hole to be dug there,) without perceiving any certain indications of the existence of salt. About the period alluded to, a gentleman from one of the mercantile cities happened to be travelling through that part of the country, and feeling somewhat disposed to enter into a salt speculation, wrote to the owner of the lands in question, stating that he would wait upon him on a certain day, when, if it were convenient, they would examine the nature and quality of the salt-spring. At the appointed time the gentleman arrived, when he and the other party, accompanied by a third person, carrying a pail and a shallow kettle or boiler, took their way through the woods to the spot where the reported treasure issued from the foot of a shelving declivity. The stranger tasted the water; it was 'salt—decidedly salt;' and the attendant having lighted a fire, the kettle was accordingly filled with water

taken from the well. In due time, evaporation having done its part, there remained a respectable quantity of salt in the bottom of the vessel, white and free from impurities; 'and,' as the Yankee proprietor observed to the stranger, 'fit for any gentleman's table.' On the following day the purchase of the land was completed; and during the purchaser's necessary sojourn from home, his head was continually filled with the idea of speedily rivalling the great salt-works at Onandaga. In due time he took possession of his new estate, having in the interim made considerable progress in arrangements for going into the salt manufacturing business upon an extensive scale. However, previous to the building of his storehouses, &c. he wished to convince a friend or two who proposed joining him in the business that all was right respecting the quality of this celebrated spring; and the whole party, with several attendants, having arrived upon the spot, an evaporating process was forthwith commenced upon. While the process was going on, he and his companions sipped a little of the water, cautiously, of course; for who would like to gulp down strong brine? and were a good deal puzzled to make out to their

own satisfaction whether or not it tasted *strongly* of salt. In two or three hours, however, the fire had driven off the water; the whole was literally gone, and not an atom of salt remained behind. This was exceedingly perplexing; the purchaser insisted there must have been some mistake in the process of evaporating. Another trial was therefore made, with precisely a similar result; when, with the evaporation of this second kettle of water, were evaporated all the golden schemes the gentleman had formed in connexion with this 'most splendid salt-spring.' The facts were simply these:—During several years the owner of the tract of land in question, who was something of a hunter, had been in the habit of taking small quantities of salt with him in his excursions through the woods, sprinkling it in and around the head-waters of this insignificant spring, for the purpose of attracting the deer, until the place got the reputation of being a deer-lick. Thus it went on for some time, when he took the trouble of digging a hole about the time he advertised the lands for sale; in which hole, on the morning of the day that the city gentleman was expected to arrive for the express purpose of examining the

salt-spring, he deposited about two bushels of salt, allowing it sufficient time to dissolve, but only a portion thereof to escape by the small outlet; so that when the water was tried that afternoon, as a matter of course a moderate quantity of salt was deposited in the kettle, and of a quality 'fit for any gentleman's table.'" We regret that the narrative does not state whether the author of this abominable fraud was found out and punished as he deserved.

It is curious to notice the great similarity in the proceedings of different nations in the attainment of the same object. Nations separated by so wide a space as that which separates America from China, are found, on a comparison of their respective proceedings, to adopt very similar processes in obtaining so necessary an article as salt. If they are far removed from the sea coast, and find no indications of rock-salt in the interior countries, except such as are afforded by weak brine springs, they endeavour to increase the supply of brine by boring. Thus, in the Chinese province of Szu-Tchhouan, on the borders of Thibet, occur a number of salt-wells with the remarkable accompaniment of springs of inflam-

mable gas; so that nature not only furnishes the brine, but also the fuel for evaporating the water and extracting the salt. There are several other wells of the same nature in the different districts of this department of Kia-Ting-Fou, and in the other neighbouring districts, situated to the east of the great chain of mountains covered with perpetual snow, which traverses the eastern part of Szu-Tchhouan, from south to north. According to the report of M. Imbert, there are in the vicinity of the town of Ou-Thouang-Khiao several thousands of these salt-wells in a space of ten leagues by five. Every person who is tolerably rich, takes a few associates with him, and digs one or more wells. The expense of digging a well is from seven to eight thousand francs, (280*l.* to 320*l.*, a large sum in China,) and the depth is commonly from 1,500 to 1,800 French feet, and only five or six inches in diameter. They are usually bored in the solid rock. These people, who accomplish the most difficult undertakings with time and patience, begin by sinking vertically into the bed of earth, usually met with at the surface, a wooden pipe crowned with a hewn stone, perforated with a hole, which, like the pipe, has the same diameter

as it is intended to give the well; that is, five or six inches. In this tube there is made to work a steel head of 300 or 400 lbs. weight. This steel is notched at the end, and is a little concave above and round beneath. A workman by leaping upon the extremity of a lever, the other extremity of which is attached to the steel head, lifts it to the height of two feet, and lets it fall again by its own weight. Some pails of water are thrown in from time to time, to assist the trituration of the substances. The spur or steel head is suspended by a cord, to which is attached a triangular piece of wood, and each time that the lever raises the cord, a second workman seated near the tube makes the triangle perform half a revolution, so that the steel head may fall in a different direction. At noon the second workman ascends upon the lever, to take the place of his companion. At night two other men take their place. When three inches have been bored, the steel head is withdrawn by means of a pulley, with all the substances with which its upper concavity is loaded. By this mode of boring the wells are perfectly vertical, and their lower surface highly polished. Beds of sand, coal, &c. are frequently

met with. The operation then becomes more difficult, and is sometimes entirely frustrated; for these substances no longer offering an equal resistance, the well loses its verticality, but these cases are of rare occurrence. At other times the iron ring which bears the steel head breaks. When this accident happens at a certain depth, the Chinese know no other means of remedying it than to employ a second steel head to break the first, an operation which may take several months. When the rock is good, an advance of nearly two feet is made in twenty-four hours, so that it may take about three years to dig a well.

The apparatus for drawing the water is equally simple with that which is employed for boring. A bamboo tube, twenty-four feet long, at the end of which is a valve, is let down into the well. When it has reached the bottom, a workman pulls at the cord which sustains it, giving it strong jerks; each jerk opens the valve and fills the tube with water. It is then drawn out by means of a kind of vertical capstan, or large windle, fifteen or sixteen feet in diameter, which is put in motion by two, three, or four buffalos or oxen, and upon this windle the cord is rolled up.

The water of these wells yields by evaporation a fifth, and sometimes a fourth, of salt. Large cast-iron cisterns, five feet in diameter, and only four inches deep, are employed for distillation. The metal is from one to three inches thick; the mass of salt, which has the form of the cistern, weighs upwards of 200 lbs., and is very hard. It is broken into three or four pieces, to be disposed of in commerce.

It is remarkable, that these saline wells are frequently, at the same time, wells of inflammable gas. If a torch be presented to the orifice of a well, when the tube full of water is coming up, it inflames and produces a jet of fire from twenty to thirty feet high, which may set fire to the shed of the well. This sometimes happens through the imprudence or malice of a workman. There are some of these wells from which no salt is taken, but which furnish enough of inflammable gas to carry on the distillation of the salt water obtained from other wells in the neighbourhood. Thus at one place in a valley four wells yielded water, and afterwards became dry. The people then dug in order to find water to the depth of 3,000 feet, but in vain. There was seen to issue a column of

inflammable air, charged with blackish particles, which continued to make its escape with a noise that was heard to a great distance. Over the orifice of two of these wells, there was built a cover of hewn stone six feet high, to prevent the approach of fire. This misfortune happened some years ago. The fire communicated itself immediately to the interior, and an explosion took place which shook the ground like an earthquake. Attempts were made to extinguish the fire by throwing upon the orifice mud, stones, or water in small quantity, means which commonly succeed when the column of inflammable air is not great; but this method proved unsuccessful, and the flame continued until a quantity of water was led to the spot sufficient to form a small lake, which being suddenly opened, was poured into the well. The expense attending this operation amounted to about 1,200*l.* which in China is a large sum.

The method adopted for employing these springs of inflammable air in the heating and lighting of the salt works in the neighbourhood, is very simple. Bamboo pipes convey the gas from the spring to the place where it is intended to be consumed. These tubes are terminated by a tube of pipe-clay,

to prevent their being burnt. A single well furnishes a sufficient quantity of gas to heat 300 kettles. The fire thus obtained is exceedingly brisk, and the cauldrons are worn out in a few months by the constant application of the flame. Other bamboos conduct the gas intended for lighting the streets and the great rooms or kitchens. Thus, nature presents in this place a complete establishment of gas-light. So abundant is the gas, that it cannot all be usefully employed. The excess is conducted beyond the limits of the salt works, and there forms three chimneys or columns of flame. The surface of the court is exceedingly hot, and burns beneath the feet. Even in January the workmen are half naked, having only a small pair of drawers to cover them. In winter the poor people, in order to warm themselves, dig the sand to the depth of a foot. With a little straw they set fire to the hollow thus formed, and sitting round it warm themselves as long as they are so inclined. They then fill up the hollow with sand, and the fire goes out. The singular circumstance of saline water and inflammable gas occurring together in the districts of Young Hian, and Wei-Yuan-Hian, can only be accounted for by the

alternation of salt beds, and beds of coal. In fact, the latter are often met with in boring the salt wells. Some coal mines are worked in this country. They contain much gas, so that lamps cannot be burnt in them. The miners obtain an imperfect light from a mixture of saw-dust and resin, which burns without flame, and is not easily extinguished. In boring the salt-wells a bituminous oil is met with, which burns in water. 400 or 500 lbs. of it are collected daily. It is used for lighting the hall in which the wells and salt-pans are situated. The salt-wells and coal-mines employ an immense number of the inhabitants; and some rich individuals have so many as a hundred wells in their possession.*

Examples of saline springs in the coal formation are not wanting in our own country. Thus, at Birtley, in the county of Durham, is a spring which, according to Mr. Winch,† produces 26,400 gallons in twenty-four hours, and contains in 1,000 grains, common salt 87, muriate of lime 43, muriate of magnesia, carbonate of lime, carbonate of iron and silica 4=131 grains. Mr. Trevelyan

* Bibliothéque Universelle.

† Geological Transactions, vol. iv.

found only 103 grains in 1,000, but he thinks it probable that the quantity of saline matter may vary at different seasons.

Salt wells probably of volcanic origin occur in the interior of the island of Java. They are dispersed through a district several miles in circumference, the base of which is limestone, like that of other parts of the island which furnish mineral and other saline waters. These wells are numerous, and gush up through apertures in the rocks, with some violence and ebullition. The waters are strongly impregnated with sea-salt and yield upon evaporation very good culinary salt. In some places the heat of natural volcanic eruptions is economically employed to evaporate the salt-water which accompanies them. This is the case at a volcanic eruption described by Dr. Horsfield about the centre of the limestone district. He says:—"On approaching it from a distance, it is first discovered by a large volume of smoke rising and disappearing at intervals of a few seconds, resembling the vapours arising from a violent surf: a dull noise is heard like that of distant thunder. Having advanced so near that the vision was no longer impeded by the smoke, a large hemispherical

mass was observed, consisting of black earth, mixed with water, about sixteen feet in diameter, rising to the height of twenty or thirty feet in a perfectly regular manner, and as if it were pushed up by a force beneath; which suddenly exploded with a dull noise, and scattered about a volume of black mud in every direction. After an interval of two or three, or sometimes four or five seconds, the hemispherical body of mud or earth rose and exploded again. In the same manner, this violent ebullition goes on without interruption, throwing up a globular body of mud, and dispersing it with violence through the neighbouring plain. The spot where the ebullition occurs is nearly circular, and perfectly level; it is covered only with the earthy particles, impregnated with salt-water, which are thrown up from below. The circumference may be estimated at about half an English mile. In order to conduct the salt-water to the circumference, small passages or gutters are made in the loose muddy earth, which lead it to the borders, where it is collected in holes dug in the ground for the purpose of evaporation."

SHORE OF THE DEAD SEA.

CHAPTER VI.

SALT LAKES—THE DEAD SEA—ACCOUNT OF THE UNITED STATES EXPEDITION TO—THEY REACH THE SEA OF TIBERIAS—DESCENT OF THE JORDAN—FIRST VIEW OF THE DEAD SEA—PROCEEDINGS OF THE EXPEDITION DURING TWENTY-THREE DAYS' RESIDENCE ON THE DEAD SEA—ANIMALS AND PLANTS FOUND ON THE SHORES—TEMPERATURE—WATER OF THE SEA—DEPTH OF THE SEA—CHARACTER OF THE SCENERY—MINERALS—RAVINES—PILLAR OF SALT—MISTS—OPPRESSIVE HEAT—SIROCCO—ATMOSPHERIC REFRACTION—DENSITY OF THE WATER—THE "APPLE OF SODOM"—SUPPOSED SITE OF THE GUILTY CITIES—HEALTH OF THE EXPEDITION—VISIT TO KERAK—COMPLETION OF THE SURVEY—SALT LAKES OF ASIATIC RUSSIA—OF AFRICA—SALT LAKE IN HINDUSTAN—IN CEYLON.

In addition to the deposits of rock-salt, and the welling up of brine springs noticed in former chapters, there are in some countries Salt Lakes, which are probably produced by the want of an outlet, and by the influx of rivers passing through a very saline soil. The most interesting of these lakes to every Christian and reader of his Bible, is undoubtedly the Dead Sea, which now covers the once beautiful valley of Siddim, which the sacred historian considered worthy to be compared with the "garden of the Lord," (Gen. xiii. 10,)

where were situated the five guilty cities, Sodom, Gomorrah, Admah, Zeboiim, and Zoar, which, with the exception of the last, were all destroyed, (Gen. xix. 23, 24,) and the surrounding country became so changed that Moses describes it as "a land of brimstone and salt, and burning." Deut. xxix. 23.

In Scripture history, this lake is known by several names, such as the *Salt Sea*, (Gen. xiv. 3; Deut. iii. 17; Josh. xv. 5;) the *Sea of the Plain*, (Deut. iii. 17;) and the *East Sea*, (Ezek. xlvii. 18; Joel ii. 20;) from its situation with respect to Judea, and to distinguish it from the West Sea or Mediterranean. It is also named by Josephus and the Greek and Latin writers, *Lacus Asphaltites*, from the bitumen found in it. It has also been named the *Dead Sea*, under the impression that no living creature could exist in its waters. The Arabs named it *Bahr-Lout*, or the *Sea of Lot*, and *Bahr-Mutneh*, or the *Stinking Sea*.

Various notices of the Dead Sea have been published by travellers, but no complete survey appears ever to have been made until the American Government, in 1847, fitted out an expedition for the purpose of circumnavigating and

thoroughly exploring it, the results of which form a valuable and interesting addition to our geographical knowledge.* This expedition was placed under the command of Lieutenant Lynch, and while the storeship, the *Supply*, was being got ready, he made preparations for the special service. He had constructed two metallic boats, one of copper, and the other of galvanized iron, so arranged as to be taken to pieces for convenience of transport across the land, between the Mediterranean and the Sea of Galilee. These boats were named *Fanny Mason* and *Fanny Skinner*. In case the taking of the boats to pieces should prove inconvenient, two low trucks were provided, with complete sets of harness. The other preparations consisted of arms, ammunition, instruments, tents, flags, sails, oars, preserved meats, cooking utensils, &c. Air tight water-bags were provided to be inflated for the purpose of serving as life-preservers, in case the boats should be destroyed. Great care was also taken in the selection of the crew, intended for the special service.

* The results are given in a volume recently published, entitled, "Narrative of the United States' Expedition to the River Jordan and the Dead Sea. By W. F. Lynch, U. S.N. Commander of the Expedition." London. 1849.

Ten young, muscular, native-born Americans, of sober habits, were chosen, and each of these was required to give a pledge to abstain from intoxicating drinks. "To this stipulation," says the commander, "under Providence, is principally to be ascribed their final recovery from the extreme prostration consequent on the severe privations and great exposure to which they were unavoidably subjected." Besides these men, Lieutenant Dale, and Midshipman Aulick were attached to the expedition; and also the commander's son, who had charge of the herbarium. To this party of fourteen persons, were subsequently added as volunteers Mr. Bedlow, and Dr. Anderson, the former at Constantinople, and the latter at Beirut, where also an intelligent native Syrian interpreter named Ameuny was engaged.

The *Supply* sailed from New York on the 21st November, 1847, and reached Smyrna on the 18th February, 1848. From Smyrna the officers of the expedition proceeded to Constantinople, in order to apply to the Sultan, through the American minister, for permission to pass through his dominions in Syria—a request which was readily granted. The officers then returned to Smyrna,

and rejoined the *Supply*, which sailed on the 10th March for the coast of Syria; and, after touching at Beirut and other places, anchored in the Bay of Acre, underMount Carmel, on the 28th. The exploring party, with the stores, tents, and boats, having landed, an encampment was formed on the beach, and the *Supply* departed on other duty, with orders to be back in time for the re-embarkation of the exploring party. "With conflicting emotions," says Lieutenant Lynch, "we saw the *Supply* stand out to sea. Shall any of us live to tread again her clean, familiar deck? What matters it! We are in the hands of God, and, fall early or late, we fall with His consent." There was certainly ground for serious thought. The fate of Costigan, and, more recently, of Lieutenant Molyneux, both of whom died of fever caught on the Dead Sea, was calculated to depress the spirits of the party.

The first practical difficulty was how to get the boats across to the Sea of Tiberias. The boats, mounted on the trucks, were laden with the stores and baggage of the party; but the small Syrian horses could not be persuaded to draw. Oxen were not to be procured, and it was determined to try whether camels could be used as beasts of

draught. Three of these huge animals were harnessed to each truck, and in the presence of an eager crowd of curious natives, the novel sight was witnessed of camels dragging heavy loads behind them, instead of carrying them upon their backs.

After innumerable difficulties, which it would be out of place here to notice, the boats were carried in triumph beyond the walls of Tiberias; "and, amid a crowd of spectators, launched upon the blue waters of the Sea of Galilee, the Arabs singing, clapping their hands to the time, and crying for *backshish;* but we neither shouted nor cheered. From Christian lips it would have sounded like profanation. A look upon that consecrated lake ever brought to remembrance the words, 'Peace, be still!' which not only repressed all noisy exhibition, but soothed for a time all worldly care. . . . Since the time of Josephus and the Romans, no vessel of any size has sailed upon this sea; and for many, many years, but a solitary keel has furrowed its surface." This solitary keel was purchased and repaired, and named *Uncle Sam.** It was used to relieve the other boats in

* This name, as well as the name of the boats employed in the service, seem very inappropriate.

transporting the baggage. On the 10th April, the boats pushed off and sought the outlet of the Jordan. The real business of the expedition having now commenced, a division of labour was made. Mr. Dale was to make topographical sketches of the country; Dr. Anderson was to make geological observations, and collect specimens; Mr. Bedlow was to note the aspect of the country on the land route, and the incidents that occurred on the march; Mr. F. Lynch was to collect plants and flowers for the herbarium; and Mr. Aulick, who had charge of the *Fanny Skinner*, was to make the topographical sketches of the river and its shores. Lieutenant Lynch, in the *Fanny Mason*, undertook to take notes of the course, rapidity, colour, and depth of the river and its tributaries; the nature of its banks, and of the country through which it flowed; the vegetable productions and the animals that might be seen; and also to keep a journal of events.

About a week was occupied in descending the river, during which time the water party generally joined the land party in the evening, and encamped on shore till the morning. So little had previously been ascertained respecting this river, that although

in its descent of sixty geographical miles there was known to be a descent of 984 feet, or in other words, the level of the Dead Sea was 984 feet lower than that of the Lake of Tiberias,—yet the existence of cataracts and rapids in the River Jordan, which connects these two seas, had been altogether denied. The course of the Jordan, however, was soon found to be interrupted by frequent and terrible rapids; so that, to proceed at all, it was necessary to send the boats with fearful velocity down these dangerous descents. On the second evening, the boats were only twelve miles, in a direct line, from Tiberias; and on the third morning, the boat *Uncle Sam* was so shattered that it was necessary to abandon her. Had not the American boats been made of metal, they must have been ruined in the rough navigation of the Jordan. Indeed, no less than twenty-seven dangerous and threatening rapids were passed, besides a number of smaller ones; and although the direct distance between the Sea of Tiberias and the Dead Sea is not more than sixty miles, yet the course of the river is so exceedingly tortuous, that the water passage is at least 200 miles. This makes the average fall of the bed of the river about six feet

per mile. The wide and deeply depressed plain through which the river flows, is mostly barren; the cliffs and slopes of the uplands are also wild and cheerless in their general character. In the lower valley, or immediate channel of the Jordan, there is vegetation. The land is not extensively cultivated, on account of the insecurity of property. The waters of the river are clear and transparent, except near the rapids and falls. Abundance of fish are to be seen in its deep and steady course, and birds were numerous. Occasionally we meet with such descriptions as the following: "For hours in their swift descent the boats floated down in silence—the silence of the wilderness. Here and there were spots of solemn beauty. The numerous birds sang with a music strange and manifold; the willow branches were spread upon the stream like tresses, and creeping mosses and clambering weeds, with a multitude of white and silvery little flowers, looked out from among them; and the cliff swallow wheeled over the falls or went at his own will, darting through the arched vistas and shadowed and shaped by the meeting foliage on the banks; and above all, yet attuned to all, was

the music of the river, gushing with a sound like that of shawms and cymbals."

Shortly before entering the Dead Sea, the waters of the Jordan become brackish, and at the mouth of the river, which is 180 yards wide, are one large and two small mud islands, evidently subject to overflow. The water here is only three feet deep, and is described as a "nauseous compound of bitters and salts."

A brisk north-west wind freshening into a gale, caused the sea to present an agitated surface of foaming brine: the spray evaporated as it fell, and left incrustations of salt upon the clothes, the hands, and faces of the party, conveying a pricking sensation whenever it touched the skin, and was exceedingly painful to the eyes, nostrils, and lips. The salt is described as being of a *greasy* character; probably from the presence of bitumen. The boats, heavily laden, struggled sluggishly, and even when the wind freshened, the density of the water was such that they could scarcely make way. The aspect of the sea was threatening, and the fretted mountains, sharp and incinerated, loomed terrifically on either side: salt and ashes mingled

with the sands, and fœtid sulphurous springs trickled down the ravines. Thus the party, fearing the worst, yet hoping for the best, prepared to spend a dreary night, upon the dreariest waste they had ever seen.

The wind, however, suddenly ceased, and with it the sea as rapidly fell; the dense waters settling as soon as the agitating cause had ceased so act. "Within twenty minutes from the time when we bore away from a sea which threatened to engulf us, we were pulling away at a rapid rate over a placid sheet of water, that scarcely rippled beneath us; and a rain-cloud which had enveloped the sterile mountains of the Arabian shore, lifted up and left their rugged outlines basking in the light of the setting sun. At 6h. 10m. a flock of gulls flew over while we were passing a small island of mud, a pistol shot distant from the northern shore, and half a mile west of the river's mouth. At 6h. 20m. a light wind sprang up from the S. E., and huge clouds drifted over, their western edges gorgeous with light, while the great masses were dark and threatening. The sun went down, leaving beautiful islands of rose-coloured clouds over the coast of Judea; but above the yet more

sterile mountains of Moab all was gloomy and obscure."

The northern shore is described as "an extensive mud-flat with a sandy plain beyond, and is the very type of desolation; branches and trunks of trees lay scattered in every direction, some charred and blackened as by fire, others white with an incrustation of salt." The north-western shore is an unmixed bed of gravel, coming in a gradual slope from the mountains to the sea. The eastern coast is a rugged line of mountains, bare of all vegetation.

The party landed for the night, and encamped in a clearing made in a cane-brake, under a cliff of old crumbling limestone, upwards of a thousand feet high, and near a shallow and clear stream of brackish water, smelling strongly of sulphur, and of the temperature of 84°. Between the cane-brake and the sea, the beach is covered with minute fragments of flint, and in the water of the sea near the shore many dead trees about two inches in diameter were standing. Having made a frugal supper, the party threw themselves, wet and weary, upon a bed of dust beside a fœtid marsh formed by the spring; "the dark fretted mountains

behind; the sea like a huge cauldron before us, its surface shrouded in a lead-coloured mist. Towards midnight, while the moon was rising above the eastern mountains, and the shadows of the clouds were reflected wild and fantastically upon the surface of the sombre sea, and every thing, the mountains, the sea, the clouds, seemed spectre-like and unnatural, the sound of the convent bell of Mar Saba struck gratefully upon the ear; for it was the Christian call to prayer, and told of human wants and human sympathies to the wayfarers on the borders of the Sea of Death."

The shore party, after leaving the green banks of the Jordan, passed over a sandy tract of damp ravines, and, ascending a slight elevation, traversed a plain encrusted with salt, and containing sour and saline bushes, some dead and withered, and snapping at the slightest touch given them in passing.

On the morning of the 19th of April, the Arabs and the camel-drivers were discharged, with their horses and camels, as it was impossible to sustain the animals on the salt and acrid vegetation of the place. At 1 P.M. the exploring party made an

excursion along the base of the mountain. They were struck with the almost total absence of round stones and pebbles upon the beach, the shore being covered, as already stated, with small angular fragments of flint. Two partridges were started, of a beautiful stone colour, so much like the rocks, that they could only be distinguished when in motion. The notes of a bird were also heard in the cane-brake; so that the statement that no animal could live upon the shores of this sea was thus disproved. "But the scene was one of unmixed desolation. The air, tainted with the sulphuretted hydrogen of the stream, gave a tawny hue even to the foliage of the cane, which is elsewhere of so light a green. Except the cane-brakes clustering along the marshy stream which disfigured while it sustained them, there was no vegetation whatever; barren mountains, fragments of rocks, blackened by sulphurous deposit, and an unnatural sea with low dead trees upon its margin, all within the scope of vision, bore a sad and sombre aspect. We had never before beheld such desolate hills, such continued barrenness. The most arid desert has its touch of genial nature:

"But here, above, around, below,
In mountain or in glen,
Nor tree, nor plant, nor shrub, nor flower,
Nor aught of vegetative power,
The wearied eye may ken;
But all its rocks at random thrown,
Black waves, bare crags, and banks of stone."

During the early part of the day, the weather was pleasant, with passing clouds; but when unobscured, the sun was warm. Towards the afternoon the wind subsided, and the calm sea, when the sun shone upon it, verified the resemblance which it has been said to bear to molten lead. On the 20th, a party was sent across the sea to take soundings: they started at 10h. 30m.; the wind had died away, and the sea was as smooth as a mirror towards either shore, but slightly ruffled in the middle, where there seemed to be a current setting to the southward. The thermometer in the tent marked a temperature of 89°, and the tent was the only shelter for the party on shore, for the sun shone fiercely into every crevice of the mountain behind. A brown or stone-coloured hare was seen at a short distance from the camp; partridges and a snipe were startled, and the twitter of a small bird was heard in the cane-brake. A beautiful butter-

fly chequered white and brown was also seen, and upon the water, about a mile from the shore, was a duck whose home was probably among the sedges of the brackish stream. Some of the sea-side brache, supposed to be alluded to in Job and translated *mallows*, was also seen, as also the *Sida Asiatica*. At 8 P. M. "the surface of the sea was one wide sheet of phosphorescent foam, and the waves as they broke upon the shore threw a sepulchral light upon the dead bushes and scattered fragments of rock." The two boats returned before 11; they had been retarded by the fresh wind and the heavy swell of the sea. The soundings directly across this, the northern portion of the sea, gave 116 fathoms or 696 feet as the greatest depth. Another line of soundings running diagonally across to the S.E. gave an average depth of 170 fathoms, or 1,020 feet, all across. The bottom consisted of blue mud and sand, and a number of crystals of salt, some of them perfect cubes. During these soundings the sun shone fiercely, and the water, greasy to the touch, made the men's hands smart and burn severely. Before night the sea had rolled up dangerously, and the crests of the waves curled over the sides of the boat. The


Mouth of the JORDAN
116
163
177½
218
156
23
Ain Terâbeh
195
194
73
161
188
17
141
Ain Jidy.
61
137
107
3
24½
13
3
2½
2
2¼
2
1¾
1½
Salt Pillar
1½
W. Ghuweir
Wady Mahras
Wen Nâr
W. Ghuweir
W. Zerka Maîn
Callirrhoe
Cascade
Grove of Palms
Riv. Arnon
W. es-Seyâl
Sebbeh
Masada
W. Rubtai el Jamus
W. Muhighghik
Kerak
W. Humeir
W. en-Nuweireh
USDUM or SODOM
1 2 3 4 5
Miles

men had a very severe pull in returning, and their clothes were stiffened with incrustation.

On the 21st of April, the encampment was moved in a southerly direction on the west shore of the sea. A 1h. 15m. P.M. they passed Wady Mahras on the Ravine of the Guard. It was dry, with a solitary ghurrah-tree at its mouth. Half a mile beyond is the Wady en Nar or Ravine of Fire, which is the bed of the brook Kedron. The head of that ravine is the valley of Jehoshaphat, under the eastern wall of Jerusalem. Midway down the ravine, is situated the convent of Mar Saba. The bed where the Kedron empties itself into the sea during the rainy season, was now found to be perfectly dry; it was much worn and filled with confused fragments of rock. It is a deep gorge, narrow at the base and yawning wide at the summit, which was 1,200 feet above. The peak of Mukulla, immediately north of this ravine, was the loftiest of the range which had been hitherto seen on the Judean shore; and presented, even more than the rest, the appearance of having been scathed by fire. Its summit is less sharp and more rounded, and the rapid disintegration of its face towards the sea, has formed a sloping hill of

half its height, resembling fine dust and ashes. This mountain, like the rest of the range to the north, consists of horizontal strata of limestone. The mountain sides and summits and the shores of this sea, were thus far almost entirely devoid of vegetation; the solitary tree already noticed alone refreshed the eye, while all else within the scope of vision was dreary and desolate. On proceeding south, however, narrow strips of canes and tamarisks were found at the foot of the cliff Wady Ghuweir, and on approaching Ain Turâbeh on a point stretching out into the sea, a few ghurrah-trees and some tamarisk bushes and tufts of cane and grass relieved the dreary scene; "all besides are brown, incinerated hills, masses of conglomerate, banks of sand and dust impalpable as ashes, and innumerable boulders bleached by long exposure to the sun."

The party camped near a small but luxuriant cane-brake, at a short distance from a fountain, the water of which was warm (75°) but pure and sweet. It trickled from the north side of a small bay within ten paces of the sea. A *pistachia* (the *terebinth* of Scripture) was found in full bloom, but its pretty white and pink flowers were scentless. Several *lily* stalks were in the stream of the

small fountain; the sand was discoloured with a sulphurous deposit. Other plants were also found, such as the *yellow henbane;* the *nightshade* or *wolf-grape,* supposed to be the wild grape alluded to in Isaiah; the *lambs quarter,* used in the manufacture of barilla; and a species of *kale* (*Salicornea Europea*). The tamarisks were in blossom; the flowers were small and of a dull white colour.

On the 22d the party again proceeded southward, and at 11h. 20m. stopped at Ain Jidy (Engaddi) to examine a ruin a short distance up the mountain side. "It is an old wall of unhewn stones without cement. The wall is on the front and two sides; the rear is the mountain side, in the face of which are several caves, with apertures cut through the rock to the air above, most probably for the escape of smoke. The walls were evidently built to defend the entrance of the caves, long subsequent to their excavation. The caves were filled with detritus, lime, and a deposit of salt in cubes. They were perfectly dry, without stalactites or petrifactions of any kind except the cubes of salt. The largest cave would contain twenty or thirty men, and has a long, low, narrow gallery, running from one side, which would be invisible

when the sun does not shine through the entrance."

The plain of Engaddi is described as a broad sloping delta, at the mouth of dry gorges in the mountains. The surface is dust, covered with coarse pebbles and small fragments of stone, mostly flint, with here and there a lotus, and some other trees. The *rock-rose*, the common *pink*, the Aleppo *senna*, the common *mallow*, and the scentless yellow *mignonette*, were also seen. On the upper part of the plain were terraces which bore marks of former cultivation; but they had been destroyed a short time before by hostile Arabs. The whole aspect of the country—these few trees and patches of vegetation excepted—was one incinerated brown. The mountain, with caverns in its face, towered 1,500 feet above; and one-third up was the fountain, in a grove of lotus. "It was a spot familiar to the imaginations of all,—the 'Diamond of the Desert,' in the tales of the crusaders."

In the evening the party received a visit from some Arabs. They were warm and hungry, and Lieutenant Lynch ordered some cooked rice to be given them. "They had seated themselves round

the pot, and were about to devour it greedily, when one of them suggested that, perhaps, pork had been cooked in the same vessel. They arose, therefore, in a body, and came to the cook to satisfy their scruple. I never saw disappointment more strongly pictured in the human countenance, than when told that the vessel had been often used for that purpose. Although nearly famished, they would not touch the rice, and we could give them nothing else."

The Arabs could not suppose that the Franks had any other object in their expedition than to search for gold; and when they saw Dr. Anderson hammering at the rocks, they were convinced that such was indeed the object.

It appears that the salt of the Dead Sea or its neighbourhood is made an article of commerce. An Arab was seen with two camels laden with salt; he was going up the pass of Engaddi to Gaza.

The 23d of April being Easter Sunday all work that could possibly be set aside was deferred. At 6 A.M. the weather was pleasant, the thermometer standing at 70° in the tent. At 7 h. 30 m. it stood at 85°. The two extremities of the sea were misty from constant evaporation; the sky

was cloudless, but the heat was so oppressive in the tent that the party breakfasted in the open air. A hawk and some doves were seen near the tent, all of the same colour as the mountains and the shore. Each day in the forenoon the wind had prevailed from the southward, and in the afternoon until about midnight from the northward; the latter was accompanied by a smell of sulphur. After midnight it generally fell calm. Although the nights were mostly cloudless, there was scarcely any deposit of dew. It is of course a necessary condition in the production of dew that the earth shall cool down by radiation below the temperature of the air; but here the ground remained heated throughout the night from the intensity of the solar rays during the day. It is much to be regretted that observations were not taken with two thermometers, one on the ground and the other suspended some feet above in the air. The dew point is never once given, nor do we find the pressure of the air once indicated. The great depression of the Dead Sea below the level of the ocean would have rendered barometrical observations of peculiar interest. But from some cause which we cannot explain, the

meteorological observations are most defective. The party seem to have been well supplied with instruments, and yet the only one which appears to have been in common use was a thermometer in one of the tents.

One of the greatest difficulties which the expedition had to encounter was to obtain a necessary supply of provisions. They had to send to Jerusalem or to Hebron for the purpose, and were exposed to the danger of being plundered on the way.

On the 24th the party were actively employed in continuing their soundings across the sea, and in measuring the angles, &c. for an accurate survey, a base line having been already measured. The greatest depth of the sea was 137 fathoms. A dead quail was found floating upon the water. At 11 h. the party reached the peninsula which juts out into the sea. "It is a bold, broad promontory, from forty to sixty feet high, with a sharp, angular central ridge some twenty feet above it, and a broad margin of sand at its foot, incrusted with salt and bitumen, the perpendicular face extending all round, and presenting the coarse and chalky appearance of recent carbonate

of lime. There were myriads of dead locusts strewed upon the beach near the margin of the sea. The summit of the peninsula is irregular and rugged. On the western side, the high peninsula, with its broad margin, extends to the southward until it is lost in the misty sea. * * There were a few bushes, their stems partly buried in the water, and their leafless branches incrusted with salt, which sparkled as trees do at home when the sun shines upon them after a heavy sleet. Such an image presented to the mind, while the frame was weltering with the heat, was, indeed, like 'holding a fire in the hand, and thinking of the frosty Caucasus.' Near the immediate base of the cliffs was a line of drift wood, deposited by the sea at its full. Save the standing and prostrate dead trees, there was not a vestige of vegetation. The mind cannot conceive a more dreary scene, or an atmosphere more stifling and oppressive. The reverberation of heat and light from the chalk-like hills and the salt beach was almost insupportable."

The tracks of a hyena were noticed on the beach. The greatest depth obtained this day by sounding was 188 fathoms (1,128 feet). The

night was sultry and oppressive, accompanied by a fœtid, sulphurous odour, which produced a feeling of sickness; but at day-break on the 25th an invigorating breeze sprang up from the north.

This day the party proceeded to explore the southern part of the sea. There was no great variety in the scenery; the same bold and savage cliffs at the mouths of the ravines, some of them sprinkled here and there with vegetation, all evincing the recent or immediate presence of water. Some of the ravines had broad flat deltas before them. The ravines all have names among the Arabs, but the deltas, or projecting plains, are not designated. At 1 h. 58 m. the party were abreast of Wady Sêyâl Sebbeh (Ravine of Acacias). The cliff above was that of Sebbeh, or Masada. "It was a perpendicular cliff 1,200 to 1,500 feet high, with a deep ravine breaking down on each side, so as to leave it isolated. On the level summit was a line of broken walls, pierced in one place with an arch. This fortalice, constructed by Herod and successfully beleaguered by Silva, had a commanding but dreary prospect, overlooking the deep chasm of this mysterious sea. * * * The cliff of Sebbeh is

removed some distance from the margin of the sea by an intervening delta of sand and detritus, of more than two miles in width. A mass of scorched and calcined rock, regularly laminated at its summit, and isolated from the rugged strip which skirts the western shore by deep and darkly-shadowed defiles and lateral ravines, its aspect from the sea is one of stern and solemn grandeur, and seems in harmony with the fearful records of the past."

The party stopped for the night in a little cave north of Wady Mubughghik, five or six miles north of the salt mountain of Usdum, which loomed up isolated to the south. "The beach was bordered with innumerable dead locusts. There was also bitumen in occasional lumps, and incrustations of lime and salt. The bitumen presented a bright smooth surface when fractured, and looked like a consolidated fluid. The Arabs called it Hajar Mousa (Moses' stone). During the night the wind was hot and blistering, and so oppressive that no one could endure a handkerchief over his face to screen him from the wind. This was doubtless a sirocco. At midnight the thermometer stood at 88°; at four the temperature of the air

was 86°, and that of the water 80°. "Notwithstanding the oppressive heat, there was a pleasure in our strange sensations, lying in the open air, upon the pebbly beach of this desolate and unknown sea, perhaps near the sites of Sodom and Gomorrah; the salt mountains of Usdum in close proximity, and nothing but bright, familiar stars above us."

On the morning of the 26th, when Lieutenant Lynch awoke, he found a young quail at his side, where in the night it had probably crept for shelter from the strong hot wind. The party started at 5 h. 30 m., and by 7 h. had reached the foot of the cliffs, which gradually slope away, and terminate in Usdum. At 8 h. 12 m. they landed on the extreme point of Usdum. Many dead bushes were found along the shore, incrusted with salt. It was a broad, flat, marshy delta, coated with salt and bitumen, and yielding to the foot. Soon after 9h. "to our astonishment, we saw on the eastern side of Usdum, one-third the distance from its north extreme, a lofty round pillar, standing apparently detached from the general mass, at the head of a deep, narrow, and abrupt chasm. We immediately pulled in for the shore,

and Dr. Anderson and I went up and examined it. The beach was a soft, slimy mud, incrusted with salt, and, a short distance from the water,

PILLAR OF SALT.

covered with saline fragments and flakes of bitumen. We found the pillar to be of solid salt, capped with carbonate of lime, cylindrical in

front and pyramidal behind. The upper, or rounded part, is about forty feet high, resting on a kind of oval pedestal from forty to sixty feet above the level of the sea. It slightly decreases in size upwards, crumbles at the top, and is one entire mass of crystallization. A prop, or buttress, connects it with the mountain behind, and the whole is covered with debris of a light stone colour. Its peculiar shape is doubtless attributable to the action of the winter rains. The Arabs had told us in vague terms that there was to be found a pillar somewhere upon the shores of the sea; but their statements in all other respects had proved so unsatisfactory that we could place no reliance upon them."

It is stated in a note that "a similar pillar is mentioned by Josephus, who expresses the belief of its being the identical one into which Lot's wife was transformed. His words are, 'But Lot's wife, continually turning back to view the city as she went from it, and being too nicely inquisitive what would become of it, although God had forbidden her to do so, was changed into a pillar of salt; for I have seen it, and it remains at this day.' Clement of Rome, a contemporary of Josephus,

also mentions this pillar, and likewise Irenæus, a writer of the second century."

On returning to the boats, some of the Arabs came up, with a species of melon, which they had gathered near the north spit of Usdum. It was oblong, ribbed, and of a dark green colour. When cut, the flesh and seeds were like those of the melon, but the taste was intensely bitter, and adhered long to the palate.

Mr. Dale landed at another part of the beach to take an observation for the latitude. His feet sank first through a layer of slimy mud a foot deep, then through a crust of salt, and then through another foot of mud, before reaching a firm bottom. The beach was so hot as to blister the feet. In returning to the boat, one of the men attempted to carry Mr. Dale to the water, but sank down, and they were obliged to flounder through it as well as they could. They described it as like running over burning ashes, the perspiration starting from every pore with the heat. It was a delightful sensation when their feet touched the salt slimy water of the sea, although its temperature was 88°.

The southern shore is described as a scene of

unmitigated desolation. "On one side, rugged and worn, was the salt mountain of Usdum, with its conspicuous pillar, which reminded us at least of the catastrophe of the plain; on the other, were the lofty and barren cliffs of Moab, in one of the caves of which the fugitive Lot found shelter. To the south was an extensive flat, intersected by sluggish drains, with the high hills of Edom semi-girdling the salt plain, where the Israelites repeatedly overthrew their enemies; and to the north was the calm and motionless sea, curtained with a purple mist; while many fathoms deep in the slimy mud beneath it, lay embedded the ruins of the ill-fated cities of Sodom and Gomorrah. The glare of light was blinding to the eye, and the atmosphere difficult of respiration. No bird fanned with its wing the attenuated air, through which the sun poured his scorching rays upon the mysterious element upon which we floated, and which alone of all the works of its Maker contains no living thing within it."

At 12h. 21m., a very loud reverberating report was heard, as if of thunder, and a cloud of smoke and dust on the western shore; probably occasioned by a huge rock falling from a high cliff. At 2h.

35 m. P.M. the party were close in with the eastern shore, but unable to land, on account of the soft bottom and the shoalness of the water. They therefore hauled to the north, towards the base of the peninsula, and found a long, narrow, dry marsh, with a few scrubby bushes, which separated the water from a range of stupendous hills, 2,000 feet high. The cliff of En-Nuweireh (Little Tiger), lofty and grand, towered above, in horizontal strata of brown limestone, and beautiful rose-coloured sandstone beneath. At 3 h. 30 m. it was oppressively hot; the temperature of the air being 97°, and that of the water twelve inches below the surface 90°, "a thin purple haze over the mountains, increasing every moment, and presenting a most singular and awful appearance; the haze so thin, that it was transparent, and rather a blush than a distinct colour. I apprehended a thunder gust or an earthquake, and took in the sail. At 3 h. 50m., a hot, blistering hurricane struck us from the south-east, and for some moments we feared being driven out to sea. The thermometer rose immediately to 102°. The men, closing their eyes to shield them from the fiery blast, were obliged to pull with all their might to stem the

rising waves; and at 4 h. 30 m., physically exhausted, but with grateful hearts, we gained the shore." They landed on the south side of the peninsula, near Wady Humeir, the most desolate spot upon which they had yet encamped. Some went up the ravine, to escape from the stifling wind; others, driven back by the glare, returned, and crouched under the awnings of the boats. One put on spectacles to protect his eyes, but the metal became so heated that he was obliged to remove them. Their fire-arms and the buttons of their coats became almost burning to the touch, and the inner folds of their clothes were cooler than those exposed to the wind. At 5 h., the heat being intolerable, they walked up the dry bed of the torrent in search of water. They found two pools with minnows in them and some plants on their margins. They washed and bathed in one of the pools, but the relief was only momentary. In an instant after leaving the water, the moisture on the surface evaporated, and left the skin dry, parched, and stiff. "Coming out from the ravine, the sight was a singular one. The wind had increased to a tempest; the two extremities and the western shore of the sea were curtained by a mist, on this side, of a purple hue,

on the other, of a yellow tinge: and the red and rayless sun, in the bronzed clouds, had the appearance it presents when looked upon through smoked glass. Thus may the heavens have appeared just before the Almighty, in his wrath, rained down fire upon the cities of the plain. Behind were the rugged crags of the mountains of Moab, the land of incest, enveloped in a cloud of dust, swept by the simoom from the great desert of Arabia."

After sunset the heat rather increased than diminished. At 8, P.M. the thermometer stood at 106° five feet from the ground, and 104° at one foot. During the night it was found impossible to allay the parching thirst, for although there was no perceptible perspiration, the fluid was carried off as fast as it was received into the system. At 9 the supply of fresh water was exhausted, "and our last waking thought was water. In our disturbed and feverish slumbers we fancied the cool beverage purling down our parched and burning throats. The mosquitos, as if their stings were envenomed by the heat, tormented us almost to madness, and we spent a miserable night, throughout which we were compelled to lie encumbered with our arms, while, by turns, we

kept vigilant watch." This precaution was rendered necessary on account of an Arab encampment at no great distance, the eastern shore being occupied by tribes whose hostility was to be dreaded.

At midnight the thermometer stood at 98°; shortly after which, the wind shifted, and blew lightly from the north. At 4, A.M., 27th April, the temperature of 82° was felt to be comparatively cool. At daybreak a large black bird was seen floating high over head. Shortly after, a large flock of birds flew along the shore, and a number of storks were seen winging their way in the grey and indistinct light of the early morning. The party started at 8 h. 45 m. with the thermometer at 94°. The Arabs, to whom some presents had been made, gathered on the shore to see the party start; they inquired how the boats could move without legs: the interpreter told them to wait, and they would see very long legs; meaning, probably, the oars. One of the boats sounded directly across to the western shore, to a shallow bay, which is mentioned in Joshua xv. 2. "Every thing said in the Bible about the sea and the Jordan, we believe to be fully verified by our observations."

At 3, there was an undulation from the north-west—the precursor of another sirocco. The boats could not gain the shelter of the cliffs before it was upon them. "The surface of the water became instantly ruffled; changing in five minutes from a slow, sluggish, unbroken swell, to an angry and foaming sea. With eyes smarting from the spray, we buffeted against it for upwards of an hour, when the wind abruptly subsided, and the sea as rapidly became smooth and rippling. The gust was from the north-west. The wind afterwards became light and baffling; at one moment fair,—the next, directly ahead; the smooth surface of the water unbroken, except a light ruffle here and there, as swept by the flickering airs." At 4h. 15m. the party stopped for the night in a spacious bay, on a fine pebbly beach, at the foot of Rubtât el Jâmûs (Tying of the Buffalo).

Early on the 28th the party coasted along the shore towards Ain Jidy. A little north of Sebbeh they passed a long, low, gravelly island, left uncovered by the retrocession of the water. There was a great refraction of the atmosphere, so that one of the boats, which had rounded the point, seemed elevated above it, and was distinctly visible

to the other boat, although the land intervened. "Notwithstanding the high wind, the tendency to drowsiness was almost irresistible. The men pulled mechanically, with half-closed eyelids, and except them and myself, every one in the copper boat was fast asleep. The necessity of steering and observing all that transpired, alone kept me awake. The drowsy sensation, amounting almost to stupor, was greatest in the heat of the day, but did not disappear at night. In the experience of all, two hours' watch here seemed longer than double the period elsewhere." At 1 h. 30 m. P.M. they came within sight of Ain Jidy, and the white tents of the camp, the line of green, and the far-off fountain, promised shade, refreshment and repose. Letters and provisions from Jerusalem enabled the party to enjoy themselves in their encampment: the air was cool and invigorating, and a bathe in the fountain restored each from his fatigues. At one time during the day, the sea below them assumed an aspect peculiarly sombre. "Unstirred by the wind, it lay smooth and unruffled as an inland lake. The great evaporation enveloped it in a thin, transparent vapour, its purple tinge contrasting strangely with the ex-

traordinary colour of the sea beneath, and where they blended in the distance, giving it the appearance of smoke from burning sulphur. It seemed a vast cauldron of metal, fused but motionless."

Experiments were made on the density of the water of the Dead Sea. A muscular man floated nearly breast high in the water without the least exertion. It had been stated that a horse driven into the water turned over from the great density of the water. A horse and a donkey were driven in, and the result was that although the animals turned a little on one side they did not lose their balance. On a subsequent day two fresh hen's eggs floated in the water. They would have sunk in the water of the Mediterranean or of the Atlantic.

Some of the blossoms, and the green and dried fruits of the osher were gathered. This fruit was considered to be the genuine apple of Sodom, described by Josephus and other writers. Josephus says:—"which fruits have a colour as if they were fit to be eaten; but if you pluck them with your hands, they dissolve into smoke and ashes." The party found the fruit of the osher to be fair to the eye and bitter to the taste, and when ripe filled with fibre and dust.

On the 29th the party continued their soundings on the sea, which is again described as "wondrous in every sense of the word; so sudden are its changes, and so different the aspects it presents, as to make it seem as if we were in a world of enchantment. We were alternately upon the brink and the surface of a huge and sometimes seething cauldron." At one P. M. the boats returned. Mr. Aulick reported a gradual decrease of soundings to thirteen fathoms nearly up the slope to the shallow basin of the southern sea. "Every thing favours the supposition that the guilty cities stood on the southern plain, between Usdum and the mountains of Moab. The northern part must have been always water, or the plain must have sunk at the time of the catastrophe."

Protected by the presence of the party from the fear of robbers, some of the Arabs came in to harvest their few scanty patches of barley. They cut the grain with their swords, and threw it upon the threshing-floor,—a circular piece of hard trampled ground, around which were driven three donkeys abreast. It was a slow and wasteful process. The animals being unmuzzled were permitted in their rounds to nip the upturned ears.

April 30 being Sunday, some of the party spent the forenoon in the quiet recesses of the ravine, endeavouring to observe the day. "Thus far all, with one exception, had enjoyed good health, but there were symptoms which caused me uneasiness. The figure of each one had assumed a dropsical appearance. The lean had become stout, and the stout almost corpulent; the pale faces had become florid, and those which were florid, ruddy; moreover the slightest scratch festered, and the bodies of many of us were covered with small pustules. The men complained bitterly of the irritation of their sores whenever the acrid water of the sea touched them. Still all had good appetites, and I hoped for the best. There could be nothing pestilential in the atmosphere of the sea. There is little verdure upon its shores, and, consequently, but little vegetable decomposition to render the air impure; and the fœtid smell we had frequently noticed, doubtless proceeded from the sulphur-impregnated thermal springs, which were not considered deleterious. Three times, it is true, we had picked up dead birds, but they, doubtless, had perished from exhaustion, and not from any malaria of the sea, which is perfectly

inodorous, and more than any other abounds with saline exhalations, which I believe are considered wholesome."

At 12h. 15m. the party embarked for the eastern shore. The sails were set to spare the men from labouring at the oars. The weather was intensely hot, and even the light air which urged the boats almost insensibly along was hot and oppressive. The sky was unclouded, and the glitter from the water with its multitude of reflectors,—for each ripple was a mirror,—added much to the discomfort of the party. The water, however, was not transparent, but of the prevailing tint of Persian opal. The black chasms and rough grim peaks above and around were veiled in a transparent mist, which gave them an unreal appearance, and 1,300 feet below, the sounding lead struck upon the buried plain of Siddim, shrouded in slime and salt. "My companions," says Lieutenant Lynch, "had yielded to the oppressive drowsiness, and now lay before me in every attitude of a sleep that had more of stupor in it than of repose. * * As I sat alone in my wakefulness, the feeling of awe returned; and as I looked upon the sleepers, I felt 'the hair of my flesh stand up' as Job's did, when 'a spirit

passed before his face;' for, to my disturbed imagination, there was something fearful in the expression of their inflamed and swollen visages. The fierce angel of disease seemed hovering over them, and I read the forerunner of his presence in their flushed and feverish sleep. Some with their bodies bent, and arms dangling over the abandoned oars, their hands excoriated with the acrid water, slept profoundly; others, with heads thrown back and lips cracked and sore, with a scarlet flush on either cheek, seemed overpowered by heat and weariness even in sleep; while some, upon whose faces shone the reflected light from the water, looked ghastly, and dozed with a nervous twitching of the limbs, and now and then, starting from their sleep, drank deeply from the water vessel, and sank back again to lethargy. The solitude, the scene, my own thoughts were too much * * I could endure it no longer; but breaking from my listlessness, ordered the sails to be furled, and the oars resumed; action seemed better than this unnatural stupor. Prudence urged us to proceed no farther, but to stop before some disaster overtook us; but the thought of leaving any part of our work undone was too painful, and

I resolved to persevere, but to be as expeditious as possible without working the party too hard."

On the 1st May, the topographical sketch of the shore lines of the deep bay on the east coast was completed, and soundings taken. On their return, the copper boat was overhauled. It was fast wearing away, from the action of the briny sea. So long as the metal was exposed to the action of the sea, it was as bright as burnished gold, but became tarnished as soon as it was exposed to the action of the air.

Most of the Arabs who occasionally visited the exploring party, regarded them as madmen for remaining so long upon the Dead Sea. They called it "the sea accursed of God," and entertained the most awful fears respecting it. Some whose curiosity led them to go out a short distance in the boats, on returning to the beach stuck plugs of onions into their nostrils, to counteract the malaria which they supposed they had imbibed from the sea.

Finding that a change of air was absolutely necessary for the health of his people, Lieutenant Lynch took them on an excursion up the mountains on the eastern shore to Kerak. The

expedition was not without danger from the Arabs, who were numerous and threatening, but the Americans, being well armed and firm in demeanour, returned in safety. In Kerah they found a community of Christians, from 900 to 1,000 in number, comprising three-fourths of the population. They were kept in subjection by the Muslim Arabs, and lived mostly in tents without the town. "If a Muslim comes to the town, instead of going to the house of another Muslim, he quarters himself upon a Christian, and appropriates to himself the best of every thing. Christian families have been two days at a time without food, all that they had being consumed by their self-invited guests. If a Muslim Sheikh buys a horse for so many sheep, he makes the Christians contribute until the number be made up. Their property is seized at will, without there being any one to whom to appeal; and remonstrance on their part only makes it worse." These poor oppressed Christians had commenced building a church, in the hope of keeping their community together, and providing a place of refuge for their wives and children in time of trouble. They entrusted to the care of Lieutenant

Lynch an appeal, written in simple but mournful eloquence, to the Christians of happier lands, for assistance. "We are," they write, "in Kerah, a few very poor Christians, and are building a church. We beg your excellency to help us in this undertaking, for we are very weak. The land has been unproductive, and visited by the locusts for the last seven years. The church is delayed in not being accomplished for want of funds, for we are a few Christians, surrounded by Muslims."

On the 4th May, the exploring party started at 6 h. 50 m. A. M. and proceeded northwardly parallel with, and a short distance from, the Arabian shore of the Dead Sea, sketching the topography as they passed. It presented the same lofty rugged brown parched hills as heretofore. At 8 h. 40 m. they came to a beautiful little stream, along the banks of which were twenty-nine date-palms in groups of two or three. This was felt to be a grateful relief to the monotonous and dreary hue of the mountains and the sea. At 9 h. they passed a stream which was visible in a long white line from the summit to the sea, into which it plunged, a tiny but foaming cataract. Its whole course was

fringed with shrubs, and its brawling noise was distinctly heard. At 10h. 37m. they stopped to examine some huge black boulders, lying confusedly upon the shore. The whole mountain from base to summit appeared one black mass of scoriæ and lava, the superposition of the layers giving them a singular appearance. In the rocky hollows were incrustations of salt. At 10h. 50m. the party started again; the scenery was grand and wild, and wherever there was a rivulet, lines of green cane and tamarisk, and an occasional date-palm tree marked its course. At 12h. 20m. they stopped in a cave formed by the Zerka Main, the outlet of the hot springs of Callirohoe. The temperature of the air was 77°; of the sea 78°; of the stream 94°, and a mile up the chasm 95°. It was slightly sulphurous to the taste. The stream has worn its bed through the rock, and flows between the perpendicular sides of the chasm and through the delta, bending to the north about two furlongs to the sea. At 7h. P.M. Lieutenant Lynch bathed first in the sea, and afterwards in the stream, "a most delicious transition from the dense acrid water of the sea, (which made our innumerable sores smart severely,) to

the soft tepid and refreshing waters of Callirohoe. The water of the sea was very buoyant: with great difficulty I kept my feet down; and when I lay upon my back, and, drawing up my knees, placed my hands upon them, I rolled immediately over." One would suppose that in such a position a bather would roll over in any water.

On the 5th of May all hands were called at 3 h. 40 m. and they crossed the sea to Ain Turâbeh. Two furlongs from the land the soundings were 23 fathoms (138 feet). The next cast, five minutes after, 174 (1,044 feet), gradually deepening to 218 fathoms (1,308); the bottom soft, brown mud with rectangular crystals of salt. At the depth of 174 fathoms, the temperature of the water was 62°; at the surface 76°. There was an interruption to the gradual decrease of temperature, and at 10 fathoms there was a stratum of cold water of the temperature of 59°.

The survey was continued on the 6th: the 7th, being Sunday, was devoted to rest. The heat was very oppressive on this day, as it was also on the 8th, when at midday the thermometer stood at 110° in the shade. The surface of the sea was covered by an impenetrable mist, which concealed

the two extremities of the eastern shore. On the 9th the business of the survey was so far complete that the two boats were taken to pieces and sent to Jerusalem. The relative densities of the water of the Dead Sea and that of the Atlantic, from 25° north latitude and 52° west longitude, were tried. Distilled water being 1, the water of the Atlantic was 1.02, and that of the Dead Sea 1.13. The latter dissolved $\frac{1}{11}$ of its weight of salt; the water of the Atlantic $\frac{1}{6}$, and distilled water $\frac{5}{17}$. The water of the Dead Sea has since been subjected to a powerful microscope, and no animalculæ or vestige of animal matter could be detected. The boats on the Dead Sea, with the same load, drew one inch less water than on the Jordan. It would have been interesting to have ascertained the rate of evaporation; as the Dead Sea has no outlet, but gets rid of the waters which pour into it from the Jordan, and from numerous smaller streams as well as from the rain, entirely by the natural process of evaporation.

The various results of the soundings appear to establish the fact that the bottom of this sea consists of two submerged plains, one elevated and the other depressed; the one averaging *thirteen*, and

the other about *thirteen hundred* feet below the surface. Through the northern, and largest, and deepest one, in a line corresponding with the bed of the Jordan, is a ravine, which again seems to correspond with the Wady el Jeib, or ravine within a ravine, at the south end of the sea. Lieutenant Lynch says:—"We have carefully sounded this sea, determined its geographical position, taken the exact topography of its shores, ascertained the temperature, width, depth and velocity of its tributaries, collected specimens of every kind, and noted the winds, currents, changes of the weather, and all atmospheric phenomena. These, with a faithful narrative of events, will give a correct idea of this wondrous body of water as it appeared to us." We must, however, repeat, that deeply interesting as this narrative of events is, and highly honourable as the conduct of the Americans must appear to every reader, yet it is to be regretted, that the only published official account of the expedition is confined almost entirely to the narrative of events from which the foregoing abstract is made. No analysis of the water of the Dead Sea is given; no meteorological table; none of that exact in-

formation which is expected at the present day from all travellers, and especially from those sent out by governments, with unlimited means.

WADY MOJEB.

On ascending the mountains towards Jerusalem, Lieutenant Lynch had a commanding view of

the scene of his late labours and dangers. He says:—"I scarcely realized my position. Could it be that with my companions I had been permitted to explore that wondrous sea, which an angry God threw as a mantle over the cities He had condemned, and of which it had been heretofore predicted that no one could traverse it and live? It was so; for there, far below, through the descending vista lay the sombre sea, and before me, on its lofty hill, four thousand feet above that sea, was the queenly city."

After the preceding details, the interest which attaches to other salt lakes must be considerably diminished. It will, however, be proper to notice one or two in this place.

In the steppes of Asiatic Russia lakes of salt-water are numerous. Their waters hold so large a quantity of salt in solution, that the action of the summer heat is sufficient to convert it into crystals, which, carried to the banks by the action of the waves, form there immense shoals of salt. Magazines have been formed on the borders of Lake Kosiak, the only lake situated on the right bank of the Irtysh, and the salt therein preserved

generally amounts to several millions of pounds. Large quantities of this article are carried every year across the Irtysh to Tobolsk. Other lakes are even richer in salt than this. Such are the Karashack, the Kalkaman, and the Djemantons, situated in the steppes on the right bank of the Irtysh. Each of these basins is from 20 to 25 versts in circumference; and the action of the sun produces in them, during the summer season, crystals of salt so numerous, that by mutual contact they at length form thick and solid arches, which like winter ice cover the surface of the lakes. These masses are frequently nine inches thick; the action of the air whitens the upper layers; the lower ones preserve a bluish tint, which in some places assumes a beautiful violet hue; and the solidity of these crystal fields is such, that horses, chariots and camels pass safely over them. Ten other lakes are also found between the Irtysh and Redoubt of Siberia.

Lake Inder in Asiatic Russia contains such an abundant supply of salt of the first quality, that it would suffice for the consumption of all the Russias, if the difficulties attending the carriage of it were not almost insurmountable; and for this

reason preference is given to the salt of the Lake Geldon or Elton, where those difficulties do not exist, though the salt of this lake is very inferior to that of Lake Inder. The latter lake is situated in the country and desert of the Kirguis, which are imperfectly known on account of the great danger of travelling in that region from the nomade tribes, who move about like Arabs, plundering caravans and travellers. A German botanist named Herman, who visited this lake some years since, has left a description of it, and it has also been visited of late years by other scientific travellers.*

On descending the river Ural, formerly called the Jaik, and in the direction of the military cordon, an advanced military post is situated about 300 versts from the town Uralsk, capital of the Ural Cossacks. This post, which is named Gorski, is situated on the right bank of the river, and faces the

* This lake was visited by Pallas in August 1773. According to him, the Kalmucks name it *Altan-nor* or the *Golden Lake*, from the yellow lustre of the surface of salt under the rays of the setting sun. The word *Elton* or *Jelton* is a corruption of *Altan*. (Pallas Reise III. 630.) The lake was also visited a few years ago by Messrs. Humboldt, Ehrenberg and Rose, and is fully described by them in Rose's Reise nach dem Ural, &c. 1842. Vol. II. p. 259.

Lake Inder. This lake is situated in latitude 48° 30′, and longitude 69°, and is elevated above the level of the river Ural. The shores are surrounded by low hills of sandstone, on which is a scanty vegetation and a few shrubs. The lake, which lies in a basin among the hills, is twenty versts in length and nine broad, and is oval in appearance. The bottom is an immense stratum of salt, covered to an inconsiderable depth with water. The saline stratum has several orifices in it; down one of these (sixteen inches in circumference) a plumb line was lowered, and no bottom was found with 180 feet of cord. The water impregnated with salt, which rests on the solid stratum, is so shallow that one can traverse the lake in every direction, either on foot or horseback. At the end of summer the water is all dried up, and the lake is covered with salt as white as snow recently fallen, and of great purity.

Those who live on the north side of the military cordon use the salt of this lake, but those who are more to the eastward use the salt of the lake in the Russian territory, being afraid to venture into the desert to supply themselves with the superior salt of the Inder. The lake has several salt springs

in it; and to the distance of ten or twelve versts round it the water is so impregnated with salt, that neither man nor beast is able to swallow it.

The vegetation of the lake bears a strong resemblance to that of the Caspian Sea, and of the salt and sandy steppes around it. The information, however, on this and other interesting points is scanty, for it seems to be impossible to spend that time in the vicinity of the lake which is requisite for its complete investigation. The disposition of the Kirguis is so hostile, and their hordes are so numerous, that notwithstanding Herman was accompanied by a numerous escort and field-pieces, it was impossible to make the tour of the lake. Indeed 2,000 Kirguis tents were pitched on the banks of the river Kara Kiel, which runs parallel with the lake at a few versts distance; these they could not pass, and consequently only saw the centre of the lake, the salt of which was crystallized in cubes.

An officer in the Russian service told Lieutenant Alexander that he was at the lake in the month of May, and saw large herds of antelopes on the sand hills, and numerous snipes near the salt pools; and swans, cranes, ducks and flamingos,

which seemed to resort to the lake to drink the water. He also said that he had a servant who was bitten there by the minute worm of the marshes, called the *Siberian plague.* Ivan, the servant, had been out all day, and in the evening when he returned to the tents, his master observed that there was a red spot on his cheek and that it was slightly swelled. His master knew what had happened, and told him that if he did not take care, he would be dead in three days; and that the only remedy was to perforate the skin of the cheek diagonally and in different directions with an awl, and to rub snuff into the wounds. Now Ivan was one of the Kirzacks or Russians of the old faith, who cross themselves in a different manner from the others; they have a number of superstitious rites and ceremonies; they have no priests, the laity officiating by turns, and each man carries with him his own plate, knife and spoon, as they will not eat out of the vessel of another. Among other things they will not touch snuff, consequently Ivan made up his mind to die; and next morning his head was swelled to an immense size. But his master did not wish to lose him; so, pretending to prepare some herbs for him, he got an awl, and pierced his cheek and

rubbed in the snuff, and repeated the operation; and though the servant was in a high fever for two days, yet at last the swelling and fever subsided together, and he recovered. Children frequently die from the bite of this worm, which in Siberia is greatly dreaded.*

The Barbary states on the northern coast of Africa are abundantly supplied with salt. That which is obtained from the mines of Morocco is of a red colour, very strong and coarse; but a white kind which is finer is produced by evaporation on the sea-coast. The lakes of Barbary are almost all as salt as the sea, and in the course of the summer many dry up entirely, leaving the mineral incrusted on their beds. Near the lake of Marks in the Algerine territory is a mountain composed entirely of salt; and all the chains which traverse it contain copious stores of this mineral. Most of the springs which are not warm are salt; and in the territory of Tunis there is no fresh water unless from rain. Many of the rivers when they dry up in summer leave their banks copiously incrusted with saline matter.

On the frontiers of the Caffre country, to the

* Jameson's Edinburgh Philosophical Journal.

east of the Cape of Good Hope, Mr. Barrow met with a salt lake. He says:—"We encamped on the verdant bank of a beautiful lake in the midst of a wood of fruit-bearing plants. It was of an oval form, about three miles in circumference. On the western side was a shelving bank of green turf, and round the other parts of the basin the ground, rising more abruptly and to a greater height, was covered thickly with the same kind of plants as had been observed to grow most commonly in the thickets of the adjoining country. The water was perfectly clear, but salt as brine. It was one of those salt-water lakes which abound in Southern Africa, where they are called *zout-pans* by the colonists. The one in question, it seems, is the most famous in the colony, and is resorted to by the inhabitants from very distant parts, for the purpose of procuring salt for their own consumption or for sale. It is situated on a plain of considerable elevation above the level of the sea. The greatest part of the bottom of the lake was covered with one continued body of salt, like a sheet of ice, the crystals of which were so united, that it formed a solid mass as hard as rock. The margin or shore of the basin was like the sandy

beach of the sea-coast, with sand-stone and quartz pebbles thinly scattered over it, some red, some purple, and others grey. Beyond the narrow belt of sand round the margin, the sheet of salt commenced with a thin porous crust, increasing in thickness and solidity as it advanced towards the middle of the lake. The salt that is taken out for use is generally broken up with pick-axes where it is about four or five inches thick, which is at no great distance from the margin of the lake. The thickness in the middle is not known, a quantity of water generally remaining in that part. The dry south-easterly winds of summer agitating the water of the lake, produce on the margin a fine light powdery salt like flakes of snow. This is equally beautiful as the refined salt of England, and is much sought after by the women, who always commission their husbands to bring home a quantity of snowy salt for the table.

"I caused a hole four feet in depth to be dug in the sand close to the edge of the water. The first two feet were through sand like that of the sea-shore, in which were mingled small shining crystals of salt. The third foot was considerably harder and more compact, and came up in flakes that

required some degree of force to break; and the last foot was so solid that the spade could scarcely pierce it; and one-fifth part of the mass at least was pure salt in crystals. The water now gushed in perfectly clear and as salt as brine."

Lieutenant Alexander describes a salt lake in the interior of Hindostan. He says:—"Upon emerging from the shaded and gently ascending path along which our road lay, we approached a low and lengthened mound, the summit of which having been attained, a most romantic and interesting spectacle was presented to us. Beneath our feet, and at the bottom of a mighty chasm, lay a deep still lake, the waters of which were slightly ruffled by the breeze, and beautifully tinted by the rays of the setting sun; it was of a circular form, and hemmed in by an amphitheatre of cliffs which rose in precipitous ridges to an elevation of 500 feet from its shores, environing it on every side and preventing completely the egress of its waters. The rocks which surround this interesting piece of water cannot be called hills, for they do not in any part tower above the surrounding country; they merely form the sides of an immense cauldron, the circumference of which is about five miles. A

solitary spring of some magnitude dashes in a small cascade from the eastern face of the rocks, and pours its waters into an artificial stone-tank, dedicated to the god Siva, issuing from which, it

SALT LAKE IN INDIA.

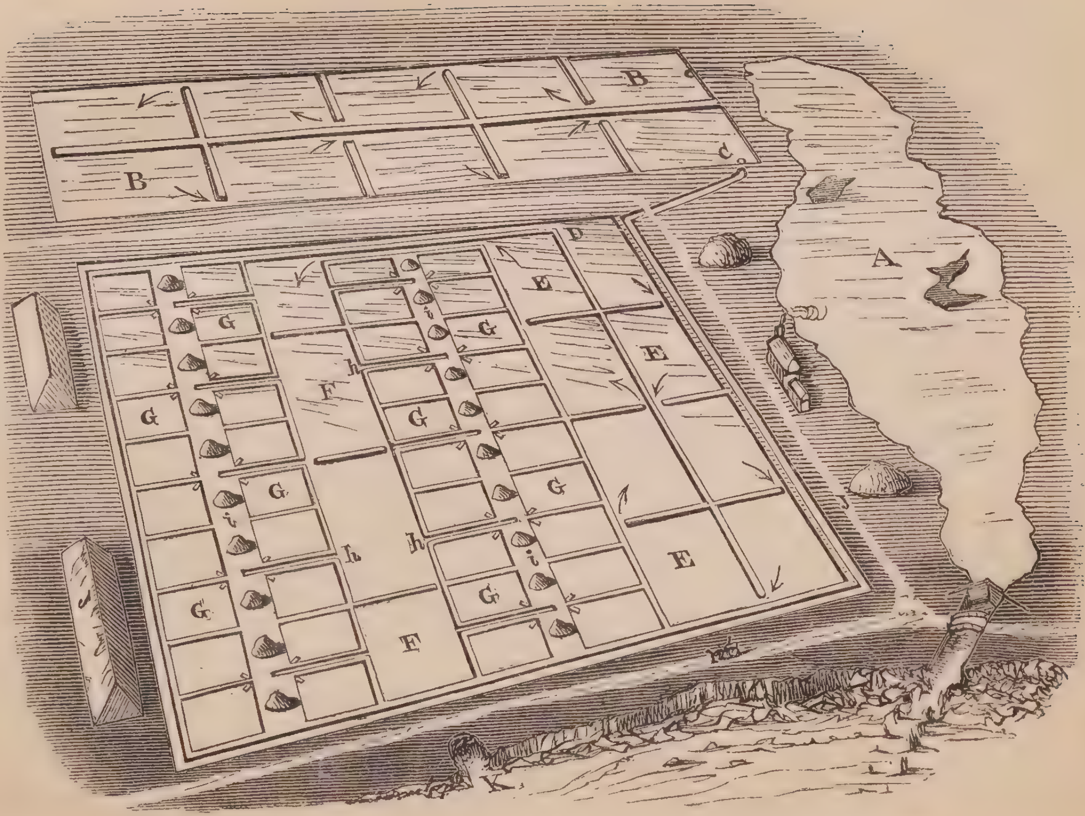
forms another cataract of about fifty feet in height before it rushes on its turbid course to join the waters of the lake. The whole landscape, though confused, is extremely pleasing. The dark green surface of these sunken waters, strongly reflects the graceful forms of the princely fan-leaved palms

which fringe the margin and advance their lofty stems over the waters of the lake. The sloping enclosure of rocks is covered half way up with mango and tamarind-trees, interspersed with the laurel-leaved rhododendron, which here attains a height of ten feet. A little picturesque temple, on the opposite side of the lake from the fountain, advances its white walls to the brink. It is seldom or never visited by the inhabitants of the neighbouring village, from the dread of tigers which inhabit the jungle around it, which also forms a shelter for numerous herds of sambars or neel-gaes. The audacity of our small party in tasting the waters of the lake, was looked upon by the villagers as the grossest presumption and fool-hardiness. The weather-worn appearance of the buildings around the spring sufficiently indicates that it has long been the seat of Hindoo worship. At this time, however, the small stone tank exhibited a lively and interesting sight; crowds of Mahratta women were employed in washing their clothes, lightening their labour with singing, whilst a solitary and aged Brahmin poured his evening libation on the uncouth statue of the god. Some years ago, before the commencement of the

Mahratta war, the annual revenue which arose from the collection of the saline crust on the margin of the lake, amounted to three lacs of rupees; since then, however, owing to neglect, the water from the mountains has so nearly filled the lake, as to leave but a small portion of the margin dry, even in the summer time, and the inhabitants have never resorted to any artificial means of extracting the salt from the water."

Some remarkable salt lakes are described by Captain Forbes in his account of Ceylon. They are near Hambantotte, which is situated on a rocky promontory joined to a steep ridge of sand, where a fortified tower commands an anchorage where vessels lie that come to ship the salt. This is formed in vast quantities on the shallow salt-water lakes, called *Leways*, that are scattered along the coast of Mágampatoo. In the dry season these lakes become covered with a crust of salt, varying in depth from the thinnest sheet of paper to the thickness of ten inches. When the salt has formed, the country, viewed from the round tower of Hambantotte, presents most peculiar scenery. In the foreground, irregular plains, covered with salt of dazzling whiteness, are every where surrounded

by forests, to which the prevalence of Daluk-trees, (*Euphorbia antiquorum*,) gives a peculiarly dark shade and sombre hue. Beyond these, at a distance of forty miles, the blue mountains of the Kandian country rise to an height of 8,000 feet; and where they cease, to the north-east, the low rugged hills of Katragamma continue the ridge almost to the sea-coast.



SALTERN.

CHAPTER VII.

SEA-WATER—ITS SALINE CONTENTS—METHOD OF OBTAINING THE SALT—SALT GARDENS OR SALTERNS—SALTERN AT LYMINGTON—SALT CATS—EPSOM SALTS—HAYLING ISLAND—SCOTCH SALT PANS—SALTERNS IN JAVA—IN NORMANDY—BRINE OBTAINED IN RUSSIA BY FREEZING SEA-WATER—SEA-SALT IN TUSCANY—SALTERNS OF SPAIN—SALT IN BRAZIL AND GUIANA.

THE waters of the ocean afford a convenient means for obtaining a supply of common salt to persons situated on or near its coasts. The saline matter of sea-water varies from three to four per cent., and of this quantity, common salt forms nearly two-thirds. The specific gravity of sea-water, varies from about 1.026 to 1.030, pure water being 1.000. Many years ago Dr. Marcet made a number of analyses of the water of different seas, and his general conclusions were as follow:—1. That the Southern Ocean contains more salt than the northern, in the ratio of 1.02919 to 1.02757. 2. That the mean specific gravity of sea-water near the equator is 1.02777, or intermediate between that of the northern, and that of

the southern hemispheres. 3. That there is no notable difference in sea-water under different meridians. 4. That there is no satisfactory evidence, that the sea at great depths is more salt than at the surface. 5. That the sea in general contains more salt where it is deepest and most remote from land, and that its saltness is always diminished in the vicinity of large masses of ice. 6. That small inland seas though communicating with the ocean are much less salt than the ocean. 7. That the Mediterranean contains rather larger proportions of salt than the ocean.

The water of the Mediterranean contains in 1,000 parts, according to the analysis of M. Laurent—

	Grains.
Water	959.06
Chloride of Sodium, (common salt)	27.22
Chloride of Magnesium	6.14
Sulphate of Magnesia, (Epsom Salt)	7.02
Sulphate of Lime, (Gypsum)	0.15
Carbonate of Lime	0.09
Carbonate of Magnesia	0.11
Carbonic Acid	0.20
Potash	0.01

There was also a trace of iodine, and of extractive matter.

It may be interesting to compare this analysis

with that of the water of the English Channel near Brighton. Dr. Schweitzer found in 1,000 grains of sea-water—

	Grains.
Water	964.74372
Chloride of Sodium	27.05948
Chloride of Magnesium	3.66658
Chloride of Potassium	0.76552
Bromide of Magnesium	0.02929
Sulphate of Magnesia	2.29578
Sulphate of Lime	1.40662
Carbonate of Lime	0.03301

The specific gravity of the water was 1.0274, and it was the same when taken from the bottom of the sea, ten fathoms deep. The quantity of iodine was very minute; 174 lbs. troy, not containing one grain of it. Dr. Schweitzer remarks, that when these analyses are compared, the Channel water will be found to contain nine times as much lime as the Mediterranean, which is to be accounted for by its flowing over a bed of chalk.

The water of the Dead Sea, according to Dr. Marcet, has a specific gravity of 1.211, and by his analysis 1,000 grains consist of

	Grains.
Water	754.20
Chloride of Sodium	103.60
Chloride of Calcium	39.20
Chloride of Magnesium	102.46
Sulphate of Lime	.54

It has been shown by Professor Daniell, that the waters of the western coast of Africa, and other localities, evolve sulphuretted hydrogen in considerable quantities, owing, as he thinks, to the mutual reaction of the immense quantities of vegetable matter, brought down by the inter-tropical rivers, and the sulphates of sea-water. It appears that this gas, which is so prejudicial to health, and so destructive to the copper of ships' bottoms, contaminates the sea in enormous quantities, through an extent of more than 16° of latitude, and extending in some places as much as forty miles seaward, making altogether an area of 40,000 square miles in extent.

At a recent meeting of the British Association, Professor Forchhammer read a paper, in which he endeavoured to show that in the ocean between Europe and America, the greatest quantity of saline matter is found in the tropical region, far from any land. In such places 1,000 parts of sea-water contain 36.6 parts of solid matter. This quantity diminishes in approaching the coast, on account of the masses of fresh water which the rivers throw into the sea; it diminishes likewise in the westernmost part of the Gulf stream, where

it was found to be only 35.9 in 1,000 parts. By the evaporation of the water of this warm current its quantity of saline matter increases towards the east, and reaches in N. lat. 39° 39′ and W. long. 55° 16′ its former height of 36.5. From thence it decreases slowly towards the north-east, and sea-water at a distance of sixty to eighty miles from the western shores of England contains only 35.7 parts of solid substances; and the same quantity of salt is found all over the north-eastern part of the Atlantic, as far to the north as Iceland, always at such a distance from the land that the influence of fresh water is avoided. From numerous observations made on the shores of Iceland and the Faroe Islands, it is evident that the water of the Gulf stream spreads over this part of the Atlantic Ocean, and thus we see that water of tropical currents maintains its character even in high northern latitudes.

The water of the different seas is much more uniform in its composition than is generally believed. The greatest quantity of solid matter ever obtained by the Professor was 37.1 in 1,000 parts, and this was from water near Malta.

It will be seen from the preceding analyses of

sea-water, that the quantity of pure water necessary to be evaporated in order to obtain the solid salt, is enormous. The method, however, usually adopted is so economical, that the salt can be sold at a very low price. The sea-water is exposed in a series of shallow ponds to the action of the sun and air, by which means the water is evaporated and the salt deposited in the hindermost pools, whilst the foremost ones are constantly supplied with fresh sea-water. This operation is carried on in what are called *salt gardens* or *salterns,* which are laid out upon a clay soil, on the sea-coast; they are secured from the influence of the tides, and are worked during the summer months from about March to September. The collecting pond A is filled at the flow of the tide through a flood-gate to the height of from two to six feet. Here the evaporation begins, but the principal object of this first pond is to allow the water to deposit its mud. The clear water is then conveyed by means of a pipe from the collecting pond to the first series of pools BB, which are quite horizontal but very shallow. From these, by means of a channel *c*, it is circulated through a channel which passes entirely round the remaining pools, and in the

saltern from which the diagram is taken this channel is 16,000 feet long; from this it enters at D into the ponds E E, from thence into F F, and lastly, runs through the open channel *h h* to a third series of ponds G G, each channel *h* conducting it into four of the ponds G G. Here the evaporation has proceeded so far that the salts begin to crystallize in the hindermost of these reservoirs, of which there are four rows. The manner in which the water arrives in these through the gutters in the sides, is shown in the diagram. A crust of salt gradually forms on the surface G, and this is broken up and collected with rakes into small heaps *i i* on the sides, and from these the mother liquor runs off into the ponds G. When no more salt separates by crystallization, the lye is allowed to run off through K into the sea. The salt, as at first collected, is too impure for use, the chief impurity consisting of chloride of magnesium: the smaller heaps *i i* are therefore made up into larger square or round heaps J, which are allowed to remain for a time covered with straw. The rain is thus kept off, and the moisture of the atmosphere suffices to liquefy the chloride of magnesium, which is thus gradually separated from the saline mass.

Although the entire surface of the saltern

amounts, together, to many hundred acres, yet the process depends so entirely upon the sun and wind, that in wet weather the evaporation sometimes entirely ceases.*

Salterns were formerly not uncommon on the coast of Great Britain, and they continued in active operation until the repeal of the duty on salt enabled the Cheshire manufacturers to sell the article at so very low a price, that the proprietors of the salterns could not compete with them. It may however be interesting to notice the method of manufacture formerly adopted at Lymington in Hampshire, as it differs in some respects from the continental plan above described. The sea-water was concentrated, by spontaneous evaporation in the saltern, to about one-sixth of its bulk, and it was then admitted to the boilers. One kind of salt was chiefly prepared there, which most nearly resembled in grain the stoved salt of Cheshire. The process varied in some respects from that already described in Chapter II. The salt was not fished out of the boiler and drained in baskets, but the water was entirely evaporated, and the whole mass of salt

* Dumas: Chimie appliquée aux Arts, tom. II.—Knapp's Technology, vol. 1.

taken out at once every eight hours, and removed into troughs with holes in the bottom. Through these it drained into pits made under ground, which received the bittern or mother liquor. Under the troughs and in a line with the holes, were fixed upright stakes, on which a portion of salt that would otherwise have escaped, crystallized, and formed in the course of ten or twelve days on each stake a mass of sixty or eighty pounds. These lumps were called *salt cats*. They bore the proportion to the common salt, made from the same brine, of 1 ton to 100.

From the mother liquor in the pits, sulphate of magnesia (Epsom salts) was manufactured during the winter season, when the manufacture of salt was suspended. The process was simple. The bitter liquor from the pits was boiled for some hours in the pans, which were used in summer to prepare common salt, and the impurities which rose to the surface were removed by skimming. During the evaporation a portion of common salt separated, and this being too impure for use, was reserved for the purpose of concentrating the brine in summer. The evaporated bitter liquor was then removed into wooden coolers one foot deep,

where it remained twenty-four hours, during which time, in clear and cold weather, the sulphate of magnesia crystallized at the bottom, in quantity equal to about one-eighth of the boiled liquor. The uncrystallizable fluid was then let off through plug holes at the bottom of the coolers, and the Epsom salt, after being drained in baskets, was deposited in the store-house. This formed *single* Epsom salts, and after being dissolved and crystallized a second time, it was termed *double* Epsom salts. Four or five tons of sulphate of magnesia were produced from a quantity of brine that had yielded 100 tons of common and one ton of cat salt.*

Hayling Island, near Portsmouth, has been celebrated for many centuries for its salt manufacture. Salt was made here long before the Conquest, and the article was in great request in foreign markets. St. Augustin, among others, celebrates the excellency of this salt, which even in his time was superior to the other salt of the British coast.

Salt is manufactured at Hayling during about four months of summer. The salterns, or *brine-*

* Dr. Henry: Philosophical Transactions. 1810.

pans as they are called, vary in size from three rods square to a quarter of an acre. In fine weather the salt-water becomes brine in about seven days. It is then pumped up by a wind-pump with sails, into four reservoirs or pits, each holding brine sufficient for making twenty-five tons of salt. From these pits the brine is pumped into the boiling house, which contains five large square shallow pans of sheet iron. There is a fire under each pan, and the brine is boiled for twelve hours. During the boiling it is twice skimmed; first one hour after it has commenced boiling, and again at the end of the fourth hour. As soon as the brine has been first skimmed, the crystals of salt may be seen rising to the top and then subsiding to the bottom. The salt is shovelled out hot and wet into wooden troughs, holding about ten or twelve bushels. These troughs have holes at the bottom through which the *bitters* run. The salt remains in the troughs ten hours, and is then removed into the store house. Epsom salts are now formed from the bitters which formerly were rejected as waste. The steam from the brine passes up large wooden flues, each of which covers two pans. One chaldron of coals per week is required for

each pan, which yields two tons of salt. In the saltern to which these details refer, about 152 tons are made during the season of fifteen weeks and a half. There are five pans in the boiling house of this saltern; each pan is nine feet square, one foot deep, and the brine is poured in to the depth of eight inches; eight bushels are made every twelve hours, and the pans are worked day and night for five days out of the seven. The salt is sold for sixty shillings a ton.*

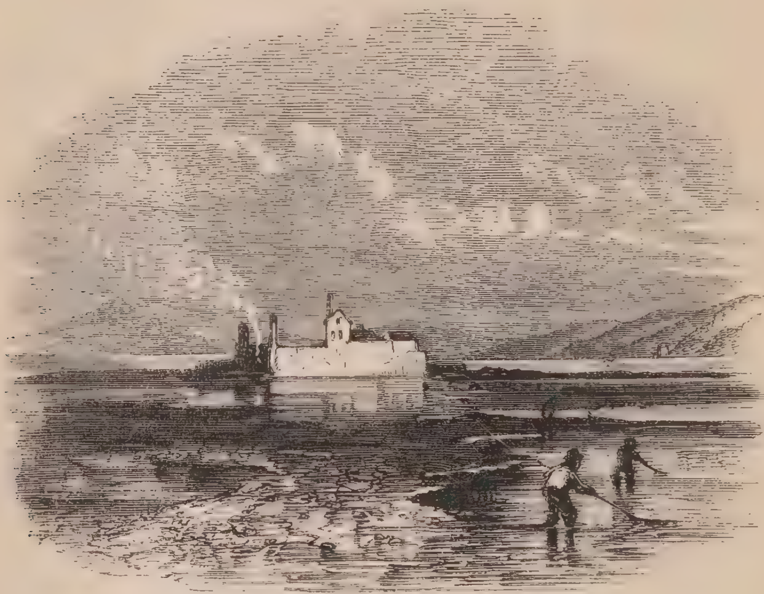
In some parts of Great Britain, where the sun's rays are not very powerful, but where fuel is abundant, salt is obtained by evaporating sea-water entirely by artificial heat. Such has been the case in Scotland for several centuries. We read of salt works being given as donations to abbeys. Thus in the year 1128, David the First gave, among other things, the salt-pan at Airth, near the head of the Firth of Forth, to endow the Abbey of Holyrood at Edinburgh. It appears also, from the chartularies of Newbottle, that that conventual establishment had salt-pans on the same estuary in the twelfth and thirteenth centuries. The manufacturing process is said to have been

* Guide to Hayling Island.

improved by some of Queen Mary's French attendants, who, in consequence, obtained from their mistress an exclusive privilege for the manufacture, and it continued a royal monopoly until the reign of Charles II. At the time of the Union, when the duties levied in England and Scotland were equalized, the Scottish salt manufacture was greatly injured; and the ruins of salt-pans along the whole coast of Fife still remain as proofs of the effects of that measure. Another injury to the manufacture was inflicted by the total repeal of the duty in 1823: this led to the abandonment of many important works.

This manufacture is conducted in the following manner:—In a suitable spot near the shore is erected a long low building, divided into two parts, one called the *fire-house*, intended to shelter the workmen and to contain the fuel; the other named the *boiling-house*, containing the evaporating pans. These are formed of wrought-iron, with the sides of lead, and are commonly each about fifteen feet in length, by twelve feet in breadth, and about fifteen inches deep. A space five or six feet wide extends on the sides of each pan, for the accommodation of the workmen. The roof of the

building, which is partly open to allow the steam to escape, is fastened with pegs of wood, as iron nails would soon be destroyed by rust. Near the



SALT-PAN ON THE FORTH.

pan is a shed containing a cistern, fixed at such a height as to allow the salt-water to flow through pipes into the pan. The cistern is filled by pumping up sea-water from a well, which communicates by means of long pipes with a pool or *lump* in the shore. When the water has deposited its mud and sand, the pans are filled and a fire lighted

in the furnace beneath. As soon as the water becomes warm, the white of three or four eggs, or a portion of sheep's or bullock's blood, is stirred in. As the heat increases the albumen of the eggs or blood coagulates and rises to the surface, bringing with it all or the greater part of the solid impurities of the salt-water. The scum thus formed being removed, the contents of the pan are left tolerably clear. After boiling about four hours, crystals of salt appear, and the water is greatly diminished in bulk: the pan is then refilled with sea-water, is clarified, heated, and skimmed as before; a process which is repeated a third and even a fourth time. The fire is then gradually slackened, and at the end of ten or twelve hours a large quantity of salt is found nearly dry at the bottom of the pan. This is raked together into one or two heaps, to allow the *bitters* to drain off. It is then conveyed in barrows to the store rooms, and laid in wooden troughs, with shelving bottoms called *drabs*, and in these the remaining bittern drains off. In three or four days the salt is fit for use. Each pan of salt requires about twenty-four hours in the making; and five pans are made every week. The furnaces, however, are never allowed

to cool; but when the workmen quit the place on Saturday afternoon, they leave water in the pans, and this goes on simmering until Monday morning, producing the *Sunday-salt* already noticed. This is in great request in some parts of Scotland, its larger grained crystals being well adapted to the salting of fish. The fuel used at the pans is small refuse coal of the Scotch pits. The salters call it their *wood*, a term probably derived from the period when wood was actually the fuel used in these salt pans. Two men attend each pan, and one is a sort of labourer to the other. These people are a peculiar race. In appearance and manners, they are not unlike colliers, whom they also resemble in another point, their former state of slavery. Until the year 1776, the salters were transferred with the works on any change of property, in as positive a manner as the black population in our own Colonies formerly were, or as the American slaves are at the present time. Their freedom was obtained by an act of Parliament, which the proprietors themselves applied for; but so little did the salters themselves appreciate this honourable proceeding, that they exclaimed against it as being nothing more than a petty attempt on the part of

the proprietors, to relieve themselves of a trifling burden, to which they were liable on the marriage of a salter or coalman.

A considerable portion of the salt thus prepared is carried by women, chiefly the wives and other relatives of the salters, to Edinburgh.

The simple process of evaporating sea-water on the sea-shore, by means of the sun and the air, in order to obtain a supply of culinary salt, is so obvious that it need not excite surprise that distant nations should adopt similar methods in order to arrive at the same result. Accordingly we find that salterns are used in a few of the islands of the Eastern Archipelago. Sir Stamford Raffles describes the salt manufactories of Java as being important both with regard to the comforts of the inhabitants and the interest of the revenue. Nearly the whole of the north-east coast of Java and Madura, abounds with places well adapted to the construction of salterns, and unfit for any other useful purpose. The process is simple and well suited to the people who practise it. On this coast the soil is of a clayey nature, and free from dark loam, which are necessary qualities to the success of the process. The salt-water is admitted

through a succession of shallow square compartments, in each of which it receives a certain degree of concentration, until arriving at the last, the water is completely evaporated, and the salt left behind fit for immediate use. The salt thus obtained, though discoloured by admixture with foreign ingredients, is remarkably free from those septic, bitter, and deliquescent salts consequent on a more hasty evaporation. This manufacture goes on during the whole of the dry half of the year. To the success of the operation, it is necessary that the soil should be clayey, to prevent the water sinking through; that the shore be flat and extensive, to give easy admission to the brine; and that high mountains should be at a distance, that the process may not be rendered difficult or precarious by the heavy rains that fall in their neighbourhood. It is the absence of this combination of favourable circumstances, that renders the manufacture of salt impracticable in most of the other countries of the Archipelago.

On the boisterous south coast of the island of Java, the shelving nature of the shore and the porous quality of the soil will not admit of the cheap process just described. The natives have

recourse to another which is curious. The sand on the beach being raked and smoothed into the appearance of ridges and furrows, as if intended for cultivation, the manufacturer having filled a pair of watering cans from the surge, runs along the furrow, sprinkling the contents in a shower upon the ridges. In a few minutes the powerful effects of the sun's rays have dried the sand, which is then scraped together with a kind of hoe, and placed in rude funnels, over which is thrown a given quantity of salt water, by which a strong brine is immediately obtained. The peasants convey this brine to their hovels, where it is boiled in small quantities over an ordinary fire, and a salt is obtained, which is necessarily impure in consequence of the haste with which the operation is performed. This salt costs fourfold as much as the better product of the north coast.* It is at the same time inferior in quality, and is only consumed in places which the latter is prevented from reaching by the difficulty of conveyance or inland tolls and prohibitions; and it has consequently been calculated that the north coast salt, if allowed to pass toll-free through the country,

* Crawford: History of the Indian Archipelago.

would in a short time supersede that from the south coast altogether. The inferior quality of the latter is caused by the quantity of the sulphate of magnesia it contains, which renders it, by its bitterness, unpleasant for culinary purposes.

Under the Dutch government the manufacture of salt on the north coast of Java was farmed out to certain Chinese, as an exclusive privilege; and under the pretext of enabling the farmer to command a sufficient number of hands for conducting his undertaking, and so to make his advances to government, extensive tracts of rice land were attached to the farms, and the farmers had unlimited authority over the population of the whole. By a continued extension of these tracts, a population far more numerous than the work at the salt-pans required was thus transferred to the Chinese, who found their advantage in renting out the rice fields and employing the people in the transport of goods and other laborious offices of the country. The consequence of this was that the farms sold for more money. Under this system, Sir Stamford Raffles cannot say what was the actual cost of the salt to the farmer: the manufacturers were partly remunerated in land

and partly in money, and the mode varied in every district; but this remuneration seldom amounted to more than a bare subsistence.

"It was the practice of these farmers-general to underlet to other Chinese the privilege of selling salt, supplying them with the article at a certain rate, and these under-farmers sold the salt again to the petty retailers in the public markets, at an advanced price. The price of the salt, after passing through the hands of the farmers, varied not only according to the distance from the place of manufacture, but according to the capital and speculation of the under-farmer. If he adopted the liberal system of obtaining small profits upon a large sale, the market was abundantly supplied at a low rate; but if, on the contrary, he traded on a small capital and enhanced the price by insufficiently answering the demand, the price became proportionally exorbitant."

In some places through which the salt was transported by inland carriage to the populous districts of the interior, the price was sometimes as high as 120 and even 140 Spanish dollars per *koyan*, while along the coast it was as low as 30 and 25. The average in 1813, when the farming

system was abolished, was about 57 Spanish dollars the *koyan*, or rather less than 30 dollars per ton. The quantity consumed annually in Java is about 32,000 tons. Under the wise and humane government of Sir Stamford Raffles, the average sale price was from 25 to 35 Spanish dollars, according to the distance from the principal dépôts, and an adequate supply, by means of smaller dépôts, was ensured in every part of the country. The salt of Java exported to the other islands of the Archipelago, competes with that of Siam and the Coromandel coast, and generally supersedes it, both on account of its quality and cheapness.

The Javanese method of obtaining salt from sea sand has been practised on the coast of Lower Normandy from the ninth century. The method is the same in principle, although the practice differs. The sand is collected on the sea-shore, where it is left dry by the tide; this is done by means of a long broad scoop, drawn by a horse; the sand is then formed into a kind of filter, through which sea water is allowed to percolate; this adds considerably to the strength of the sea water, which is then evaporated in shallow leaden

boilers; the fuel is wood; and during the boiling, the scum which rises to the surface is removed. The boiler is filled up many times until a quantity of salt collects in it; the salt is then kept in constant motion by means of long rakes, to prevent the lead from fusing. The evaporation is continued until the salt is dry. In this state it

is very impure, and is taken out by means of a perforated tool, shown in the figure, and placed in baskets which are suspended over the boilers, and the steam which rises from them in the next operation of evaporating penetrates the baskets and washes out a large portion of the bitter deliquescent impurities. The salt is then removed to warehouses, and, with the assistance of the tool shown in the figure, piled up on the floor, which is formed of a close hard cement. Here the salt parts with another portion of its impurities,

and in the course of two months loses from 20 to 28 per cent. The salt is then very fine and pure,

and as white as snow. From 700 to 800 litres of salt water produce from 150 to 225 kilog. of salt. The lead-pans being subjected to this constant heating and cooling, soon become permanently enlarged in size, and require to be frequently reset.

In some parts of Asiatic Russia, advantage is taken of the cold of winter to obtain salt by the congelation of sea-water. The method is founded upon this remarkable property—that when brine is exposed to a temperature some degrees below the freezing point, it resolves itself into two portions, one consisting of pure water, which freezes, and can be removed as solid ice; the other consisting of brine, which does not freeze, but becomes of course intensely salt by the removal of the fresh water. The solid salt is then obtained from the brine by the usual process of boiling.

The salt thus obtained is, however, very impure, unless the precaution is taken beforehand to purify the brine by means of lime. The effect of the low temperature is to decompose a portion of the common salt, and to convert the sulphate of magnesia of the brine into sulphate of soda and chloride of magnesium. In the salt obtained from

the brine separated by freezing a portion of water from the sea of Okhotsk, M. Hess found:—

Common salt	77.60
Sulphate of soda	13.60
Chloride of aluminum	6.20
Chloride of calcium	0.94
Chloride of magnesium	1.66
	100.00

M. Hess attributes the scorbutic diseases which are so common in the places where this salt is used, to the presence of these chlorides. M. Dumas remarks that this is the first analysis of bay-salt in which chloride of aluminum has been found.

On the coast of Tuscany, the sands left by the tide, when dried by the heat of the sun, are frequently incrusted with salt; but as the manufacture of this article is a government monopoly, no one is allowed to gather it. Captain Basil Hall relates a circumstance as told to him by an inhabitant of Tuscany, illustrative of the jealous care with which the monopoly is guarded:—"Not only are the ordinary steps taken to prevent the intrusion of competitors in the open market, but such is the dread of a rival manufacture, that it is actually against law to draw a bucket of

water; so that when my children were once directed to be washed in salt water, I was obliged to apply for a regular commission from the Custom-house before my servant would venture to bring a couple of gallons from the shore. One summer's day when my sons were bathing in a shallow part of the coast, they were surprised to observe a thin but extensive coating of salt on the surface of the sand, caused, no doubt, by the sun's having evaporated the water. The boys wondered that so valuable an article, as they had been taught to consider salt, should be left on the beach to melt in the rain, or to be washed back again into the surf. Thinking no evil, of course, they collected a towel full, and brought it to me, who was as much surprised as the lads. But while we were standing around this newly-discovered treasure, and speculating on the strange fact of its being allowed to run to waste, one of the Italian servants, who happened to be passing, saw the contents of the towel. Turning as white as the salt itself, he exclaimed, 'In the name of the Virgin, how could you be so imprudent as to pick up salt from the sea-shore? Don't you know that you are subject to a heavy fine, for infringing the laws of

the country? Even now,' continued the greatly alarmed domestic, 'it is my duty to give information to government; otherwise, if it becomes known, I shall be punished.' The salt was, by general consent, buried in a hole in the garden, as a means of avoiding troublesome consequences."

On the sea-coast of Spain and the marshes near it, salt is produced in considerable quantity by solar evaporation. Thus at San Fernando, the capital of Isla de Leon, in the south, salt is the staple. It is made in the Salinas, and the marshes below; "where," says Mr. Ford, "the conical piles of salt glitter like the ghosts of British tents. The salt-pans have all religious names, like the wine cellars of Xeres, or the mine shafts of Almaden. This which sounds irreverent to Protestant ears, gives no offence to the Spaniards, for the most sacred names become desecrated by familiar use." In these salt marshes breed innumerable small crabs. The foreclaws are tit-bits for the Andalusian epicures, and are called *Bocas de la Isla.* They are torn off from the living animal, which is then turned adrift in order that the claws may grow again for a new operation.*

* Ford: Handbook for Travellers in Spain.

The salt with which the English salt their cod at Newfoundland is the bay-salt obtained from St. Ubes and Alicant on the coast of Spain, whither the ships proceed with ballast to load with salt. They then proceed to Newfoundland, and return to Spain and Portugal with salt cod, for which a ready sale is found. A French writer, referring to this trade says,—"It is a remarkable singularity in the history of commerce, that a Protestant nation should furnish a Catholic kingdom with an article which that nation only can prepare according to the taste of the consumers, by fetching from their own coasts the salt necessary to cure the fish taken upon the banks of Newfoundland, an island discovered by the Spaniards! and, as if this species of servitude were inevitable, all the attempts hitherto made to substitute fish taken on the coasts of Biscay and Asturias, resembling English cod, have been ineffectual; and have proved that laws, policy, and even interest, disappear before the caprices of taste." *

The consumption of English cod was greatly diminished during the last war, although neutral

* Bourgoanne: Travels in Spain.

vessels took quantities to Spain under the title of *French cod.* The *baccalar* of Norway has been substituted for English cod in different parts of the kingdom, particularly at Barcelona, where it is preferred; but in almost every other part of Spain, although not so good as the baccalar, there is a marked predilection in favour of English cod.

In some parts of Brazil, in South America, salt is obtained by a species of solar evaporation, which is peculiar. The most important salt district in Brazil commences at the Rio de Salitre, a tributary of the Rio de S. Francisco, about six leagues from Joazeiro. At this place an artificial hollow extends along the river for the space of 60,000 square feet, and a fine, soft, ochre-coloured earth forms the bottom of the trough. The annual floods melt the saline particles contained in this mould, and when the river falls a salt-pool is left. The heat of the sun then evaporates the water, and the surface is left covered with salt. The soil is of a similar conformation along the bed of the San Francisco for an extent of nearly two degrees of longitude, and everywhere nearly thirty leagues in breadth. Hollows such as these, both

natural and artificial, are scattered over the whole extent, and form the salt-mines of the country. The greater number belong to the wealthy land-owners on the Rio de San Francisco, but many, especially on the western side, are unappropriated, and may be worked by any one. At certain seasons this district is visited by immense multitudes, some from very great distances. The earth is dug up to the depth of an inch, and deposited in wooden troughs; water is then poured upon it, which dissolves the salt. The earth being allowed to subside, the salt-water is drawn off into another trough, and left to crystallize in the heat of the sun. The salt is packed in four-cornered bags of cow-hide, each containing from 30 to 40 lbs. Salines, nearly as productive as these, are found at the sources of the Paraguay, in Matto Grosso, and considerable quantities of salt are manufactured on the shores of the northern provinces.

In Guiana there is a very common species of palm, the flowers of which are enveloped by a sheath capable of holding many pints of water. When this sheath is full of water it may be placed over the fire without being destroyed, because the

heat passes through it, and is absorbed by the water so quickly that it has not time to injure the sheath. The Caraibs employ these sheaths for the purpose of evaporating sea-water, and thus quickly obtain a supply of salt.

CHAPTER VIII.

SALT IN INDIA — SALT GROUND — THE SALT RANGE — THE SALT MONOPOLY — SALTERNS IN BENGAL—SALE OF SALT IN BENGAL—REPORT OF PARLIAMENTARY COMMITTEE—EVILS OF THE MONOPOLY—HIGH PRICE AND DEFICIENT SUPPLY OF SALT—SMUGGLING—THE CHESHIRE MANUFACTURERS—PROPOSED CHANGES—SECOND REPORT OF PARLIAMENTARY COMMITTEE—CHANGES MADE BY THE COMPANY—DISCOVERY OF SALT IN SCINDE.

British India does not appear to be well supplied with salt. In some parts the soil is impregnated with that mineral, forming what is called a *salt-soil* or a *salt-ground*. Thus, near to Vencataghery, common salt appears to be generally diffused over and through a black poor soil, where it is collected and used for culinary purposes. Between Baydamungulum and Taycululum, Buchanan had an opportunity of examining one of the places where salt is made. The situation was low and moist; the soil, a black mould consisting of a mixture of sand and clay, which, from its appearance, would have been

reckoned good; but the impregnation of salt renders it greatly inferior, for the purposes of cultivation, to soils of an apparently worse quality, but free from salt. The natives allege, that if they walk much on this saline earth, their bare feet become blistered. In the dry season, the surface of the earth is scraped off and collected in heaps. In front of these heaps, the native salt-makers construct a semicircle of small round cisterns, each about three feet in diameter and a foot deep, with sides and floors of dry mud. Toward the heaps of saline earth, there is in the floor of each a small aperture, with a wooden spout to convey the brine into an earthen pot placed in a cavity below. The floors of the cisterns are covered with straw, and the saline earth is put in till it rises nearly to the level of the tops of the walls. On the surface of the saline earth water is then poured, which in filtering through into the pots carries with it all the salt. The spent earth being thrown out behind the cisterns, is replaced with new earth for saturating more water. In the mean time the brine is emptied into a cavity cut in a rock, and is evaporated entirely by the sun. The natives say

that the salt is sufficiently wholesome. The grain is large, and consists of well-formed cubes; but the salt is mixed with much earthy impurity. It is principally used by the lower orders.

An extensive group of mountains, called the Salt-range, stretches from the base of the Suliman mountains in Afghanistan, in an easterly direction, to the river Jailum in the Punjaub. It is known to the natives in different parts by many different names; but among Europeans it has acquired the general term of Salt-range, from the great extent and thickness of the beds of common salt which it in many places contains. One which is now being worked is 200 feet thick, and the salt varies in colour from white to flesh-colour and brick-red. It is granular, the concretions being very large and compact, so that platters and other utensils are made out of it, and take a high polish. Jameson states it to be so pure as only to require grinding; but Burnes describes it as being mixed with some substance, probably magnesia, which renders it unfit for curing meat. When the last-named writer visited the mines in 1822, the total quantity of salt raised in a year amounted to 80,000,000 lbs., and it was sold at the mine at the

rate of 50 lbs. weight for a rupee. Since that time the price has been doubled by Gulab Singh, who now holds the mines.

The air of these mines has the most pernicious effects on the health of the persons employed in them, producing, it is said, chronic and wasting catarrh, and distressing and fatal affections of the lungs. In consequence, the average duration of life among the miners, does not exceed thirty-five or forty years. Considerable skill has been shown in the working of these mines, and they have been long celebrated.

The elevation of the range is not considerable, no summit, probably, attaining the height of 2,500 feet above the sea. The mountains are bold and barren precipices, rising at once from the plain, and presenting a forbidding aspect of desolation. The Indus traverses a portion of this range, making its way down a deep, narrow, rocky channel. Elphinstone thus describes the scene near Kala-bagh:—"The Indus is here compressed by mountains into a deep channel, only 350 yards broad. The mountains on each side have an abrupt descent into the river, and a road is cut along their base for upwards of two miles. It had been

widened for us, but was still so narrow, and the rock over it so steep, that no camel with a bulky load could pass. To obviate this inconvenience, twenty-eight boats had been prepared to convey our largest packages up the river. The first part of this pass is actually overhung by the town of Callabaugh, which is built in a singular manner upon the face of the hill, every street rising above its neighbour, and, I imagine, only accessible by means of the houses below it. As we passed beneath, we perceived windows and balconies at a great height, crowded with women and children. The road beyond was cut out of the solid salt at the foot of cliffs of that mineral, in some places more than 100 feet high above the river. The salt is hard, clear, and almost pure; it would be like crystal, were it not in some parts streaked and tinged with red. In some places salt-springs issue from the foot of the rocks, and leave the ground covered with a crust of the most brilliant whiteness. All the earth, particularly near the town, is almost blood-red, and this with the strange and beautiful spectacle of the salt rocks, and the Indus flowing in a deep and clear stream through lofty mountains past this extraordinary

town, presented such a scene of wonder as is seldom to be witnessed."

In the province of Bengal, the manufacture and sale of salt have been for many years a monopoly of the East India Company. In the various Parliamentary inquiries which have been made of late years into the affairs of the Company, the subject of this salt monopoly has been fully inquired into, previous to the renewal of the Company's charter, and also on the petition of the Cheshire salt manufacturers to be allowed to import salt into the province of Bengal. The following particulars are derived chiefly from the voluminous reports of the Parliamentary Committees.

The origin of this monopoly was of slow growth. At an early period in the history of the Company, they acquired from the Mogul emperors an exemption from all duties, "on whatever goods and merchandise their agents might bring or carry, by land or by water, in the ports, quarters, and borders of the provinces." The agents gradually succeeded in getting this exemption extended to every kind of goods bought and sold by them, and thus the Company were able to sell at a higher

profit than other traders. *Dustucks* or *permits* were granted to the privileged parties, and the system led to much abuse. By the year 1765, the trade in salt by the government agents, under this system of permits, had become so oppressive to the natives, that the Company determined to make some alterations. Lord Clive suggested a plan by which the trade would improve the revenues of the Company, and at the same time be free from many of the abuses to which it had hitherto been open. This plan was acted upon, and by it all private dealers in salt were recalled from the interior; a society was formed for the exclusive purchase and sale of salt at certain specified markets; the shares were distributed among the Company's servants; a committee was appointed to manage its affairs, and the society undertook to pay the Company a duty of 35 per cent. on the selling price of the salt. This plan, however, did not continue long, and the operations of the society were confined to Calcutta, where their salt was sold at certain fixed prices to native merchants, who were limited in the quantity allotted to them. These merchants sold the salt to the retail dealers also at certain fixed prices, and by them it was

distributed throughout the country. The government duty was now raised to 50 per cent.

The Directors in London disapproving of this society, ordered it to be abolished, with compensation to the shareholders. The trade was then thrown open to private merchants under certain restrictions, intended to prevent monopoly and oppression. This lasted till 1772, when a new plan came into operation, by which the salt was manufactured by the Company's own agents, who farmed the salterns for periods of five years, and agreed to deliver the salt at a certain stipulated price, and the Company sold the salt to the dealers at an advanced price. In 1777, this plan was so far altered, that the persons who farmed the salterns were allowed to sell the salt to whom they pleased. In 1780, another modification took place, by which the salt was manufactured by the Company's agents, who were allowed a per centage on the proceeds, and the salt was sold at a price regulated by the government at the commencement of every season. In 1787, the salt was ordered to be sold by public auction instead of at a fixed price; the district subject to the salt monopoly was divided into five agencies, each of which was superintended by an

European officer at a salary. This plan has continued in operation almost down to the present day.

The district appropriated to the manufacture of the salt was chiefly in the Cuttack or the Delta, formed by the river Mahanuddy, to the south-west of Calcutta and the Sunderbunds, which comprise the district included within the Delta of the Ganges. The physical features of the two districts are very similar. The marshy woodland tract of the Cuttack extends along the sea-shore, abounds with swamps and marshes, with numerous winding streams swarming with alligators; with dense jungles and a noxious atmosphere. Northward of Kanka, the quantity of jungle diminishes up to the neighbourhood of Balasore; but the whole space is intersected by numerous nullahs which deposit, and creeks which retain, a quantity of fine mud, forming morasses and quicksands highly dangerous to the unwary traveller. The surface of the whole is covered with coarse reedy grass and brushwood, valuable as fuel to the salt manufacturers. Extensive thickets of the thorny bamboo render travelling impracticable in many parts except by water. The jungles abound with leopards, tigers, and wild buffaloes; and the rivers,

at the flowing of the tide, are thickly infested with large and voracious alligators. The climate seems hurtful even to the natives, who are subject to many diseases.

The salt manufactured in this inhospitable tract is called *pangah*, or that sort produced by boiling. The process observed by the Molunghees or manufacturers, is rude and simple to the last degree. The sea-water, which is brought up by various small channels to the neighbourhood of the manufacturing stations of *khalaris*, is first mixed up and saturated with a quantity of the salt earth, or efflorescence, which forms on the surface of the low ground all around, after it has been overflowed by the high tides, and which being scraped off by the Molunghees, is thrown into cylindrical receptacles of earth, having a vent underneath, and a false bottom made of twigs and straw. The strongly impregnated brine filtering through the grass, &c. is carried by a channel dug in the ground to a spot at hand surrounded with an enclosure of mats, in the centre of which a number of oblong earthen pots, generally about 200, are cemented together by mud into the form of a dome, under which is a fire-place or oven. The brine is poured into this

collection of pots, or choolahs, and boiled until a sufficient degree of evaporation has taken place, when the salt is taken out, as it forms, with iron ladles, and collected in heaps in the open air. The heaps are afterwards thatched with reeds, and remain in this state until sold or removed by the officers of the agency.*

The Molunghees receive a certain stipulated sum for a given weight of salt manufactured; and as they are always extremely poor, the payment is made in advance. At the end of the season, when the prescribed quantity of salt is manufactured, the officers and the labourers met the Company's agent on an appointed day: each labourer had what is called a *hath chittee*, or book, in which the money advanced to him from time to time was entered: the quantity of salt being produced, the accounts were examined; if the whole of the money had not been advanced the Molunghees now received the balance. It is stated that in 1831 upwards of a hundred thousand Molunghees were employed in the unhealthy districts of the Cuttack, and the Sunderbunds. These districts are sometimes exposed to irruptions of the sea.

* Asiatic Researches, vol. xv.

In 1825 an irruption of the sea swept away at Hattiak Sunguttry in Chittagong 318,000 maunds of salt, and many thousand persons. The supply of salt thus obtained by the Company was exposed for public sale at Calcutta, in lots, every month. Each lot varied from 500 to 1,000 maunds, (the maund being equal to about 82 lbs. avoirdupois.) The price varied from about 350 to 450 rupees per 100 maunds, averaging about 12*s.* 9*d.* per cwt.* Most of the purchasers were wealthy

* In the report of the Parliamentary Committee of 1831-2 it is stated that this price is about 288 per cent. above the original costs and charges. In Madras, salt is sold at a fixed price which does not exceed one quarter of the average price at Bengal, but the rate of profit nevertheless is somewhat higher, inasmuch as the cost of production is comparatively small.

The committee state that the average amount of net revenue during three years, amounted to 1,600,000*l.* which the committee concluded to be too large to be given up, and which they had no reason to think could be commuted for any other tax less burthensome to the inhabitants.

The committee think that Bengal might obtain a cheaper supply of salt, by importation from the coasts of Coromandel and Malabar, Ceylon, the Gulf of Persia, and even Great Britain, than by the system of home manufacture. They recommend that Government contract for the delivery of salt, by advertisement, into the public warehouses of the port of Calcutta, at a certain price per ton. That the home manufacture be gradually diminished, beginning in those districts in which the cost of production and the loss of human life are greatest, until so large a

Hindoos, residing at Calcutta, and they were allowed to remove the salt from the Company's warehouses at their convenience, a rent being paid to the Company for warehouse room if the salt was allowed to remain after the sale.

The circumstances which led to these monthly sales, are thus stated by Lieut.-Col. Galloway:—

"The prohibition of European merchants from purchasing salt at the Company's sales, has thrown the trade in salt into the hands of a few native monopolists, who regulate the price at will. Government receive about three rupees per maund; but the salt is resold under their eye at five rupees in Calcutta by retail, after being adulterated with ten to fifteen per cent. of earth and dirt. The reasons which gave birth to this restriction have long ago ceased to exist. The restriction is obviously adverse to the interest of the Company,

proportion of the consumption shall be supplied from abroad, that it might be safe to permit the free importation of salt under a custom duty to Government, sanctioning the manufacture in such districts only, (if any,) where it could then be profitably carried on. Under such an arrangement a material reduction might be effected in the price of salt, which would prove of the greatest advantage to the native population of India, to whom a cheap supply of this necessary of life is of the utmost importance.

and no less so to that of the natives, who are now left at the mercy of a few native dealers. These lately availed themselves of the power which the restrictive law gives them, to such an extent, that in some districts the price of salt rose to ten and twelve rupees per maund; so that the poorer classes were compelled to deny themselves the use of it altogether, a circumstance which distressed the government beyond measure, but they were for the time at least without the means of affording relief."

"In the year 1823, I think it was, the salt was bought up at the Company's sales by an association of Calcutta Baboos, who succeeded in forming a true monopoly; not a monopoly of production with sale of the produce to the highest bidders, as is the present salt system, but a monopoly of sale,—of sale not to any bidder, but at their own price. The consequence was, the salt rose to twelve rupees per maund where it generally sold for five, and in many places it was not procurable at any price. To prevent this in future, Government established monthly sales."

This regulation, however, did not render salt a cheap article to the natives. It still had to pass

through the hands of many dealers, before it reached the poorer classes, and each dealer made his own profit either by increasing the price or by adulterating the article with a worthless substance. The merchants who purchased the salt from the Company, were called *Dhuratias*. They made their purchases at the public sales, and either sold the salt immediately to the retail dealers at a profit, or they kept it in store in the Company's warehouses until the scanty supply had raised the price in the market, and thus enabled them to make larger profits. Another description of dealers were *second-class Dhuratias*, men of limited capital who traded somewhat on the principal of stock-jobbing in the Funds. They paid a deposit on their purchases at the Company's sales, and endeavoured to sell before the expiration of the time allowed by the Company for payment. They sometimes lost by the bargain, if prices were not favourable. A third variety of dealers were the *Baugahs*, men of sufficient capital to pay for their purchases, and to convey the salt by an expensive land or water carriage to the interior, where they sold it retail in their own warehouses. The salt was sometimes conveyed by these people a distance

of 400 to 800 miles against the stream, or to a considerable distance in carts or on bullocks. The *second* and *third-class Baugahs* were merchants who differed from the former in allowing a system of credit, whereby the price of the salt was also increased. A lower grade of dealers were the *Assamees*, who bought salt of the Baugah merchants and sold it in smaller quantities to the *Moodies*, and to large families. The *Moodies* were the lowest class of dealers, who furnished the smallest quantities to poor persons.

Such is a brief outline of the system by which the vast population of the presidency of Bengal was supplied with salt. A few extracts from the parliamentary documents already referred to, will show how this system worked.

The evidence of John Crawfurd, Esq. is interesting. This gentleman was during six years the chief civil officer in Java, and had the charge of the salt monopoly in that island. He has also made the salt trade a subject of inquiry in various parts of India. According to his evidence, the country supplied with salt of the monopoly has been uniformly the same, from the year 1790, when the monopoly was established on its present

footing. This territory is estimated to contain 144,762 square miles. When the monopoly commenced, the population was reckoned at twenty-four millions. In the year 1823, it was estimated at 35,593,309 souls. This, however, is only a calculation, no census of the population of Bengal having ever been taken. Supposing no salt to be smuggled, the clearances of salt would give 7.69lbs. per head, estimating the population in 1835 in round numbers at 42,000,000.

The boiled salt of Bengal probably resembles the boiled salt now manufactured to a small extent in Scotland and Ireland, which was formerly manufactured largely, from sea-water only, but more impure, because the process is more imperfect and hasty. It contains muriate of magnesia and sulphate of magnesia, and also mechanical impurities, and is deficient in the qualities necessary for the preservation of animal and vegetable substances. As seen in the Company's stores before it is sold at the public sales, it appears tolerably pure, although there is a great deal of mechanical admixture; but as it appears in the common markets, it is generally a very abominable looking affair, bearing a considerable resemblance to

the commodity produced on French tables, under the name of salt. It looks like a mixture of pepper and salt. It is impossible for any European, or native of rank, to use it in that state. It is always refined, and at considerable expense, by Europeans, who clarify it by means of white of egg. The amount of adulteration is said to be ten or twelve per cent.

The following is an extract from the minutes of evidence:—

"684. I have understood you have specimens of the boiled salt of Bengal; can you exhibit any of it to the committee?—I have brought a sample of it to show the committee.

[The witness produced a sample of salt.]

"685. Is this salt in the state in which it issues from the Company's sales?—No, by no means.

"686. Is it adulterated salt?—Yes, as it is generally exhibited in the markets in the provinces subject to the monopoly. I have shown it to several gentlemen who have been in India, and they recognised it at once. To give a fair opinion of it, it is necessary that a larger sample should be produced; this was procured from a ship in the

St. Katherine's Docks, the Sophia. There was great difficulty in getting any, for this reason, that ship-owners and merchants trading to India are quite aware of the badness and high price of India salt, and they send out a sufficient quantity for the outward-bound voyage as well as the homeward, so that it is only by accident you are able to get any from an Indian ship. Perhaps the specimen before the committee is somewhat dirtier than what is usually seen; there are more lumps of dirt in it; but on the whole, I think it is somewhat whiter than what is generally produced in the Indian bazaars. I should not, in respect to impurity, consider it an unfair sample of all the monopoly salt retailed to the people of India, subject to that monopoly.

"687. What are these lumps?—They are mud."

Mr. Crawfurd considers that there is no country in the world in which salt is higher priced than in Bengal, in reference to its absolute price, and still more in reference to the capacity of the people who consume it. Rice, which is the bread of all the inhabitants of those districts subject to the monopoly, is a peculiarly insipid food, and the people use very little fish or animal food of any

kind, so that an abundant supply of salt is more necessary to them than to most people.*

Mr. Crawfurd estimates the annual cost of salt to a rural labourer, to which class the great mass of the population of Bengal belong, as being equal to about two months' wages, or one-sixth of his whole annual earnings. It is about the same thing as if it were to cost the rural labourer in England 4*l.* per annum for the salt he eats, or one-sixth of his earnings, taking his wages at 24*l.* a-year. The average wages of a rural labourer throughout the district subject to the monopoly, are 24 rupees a-year, (or 48*s.* taking the rupee at 2*s.*)†

* Colonel Colebrook says:—"The high price of salt throughout India is not only the occasion of much distressing privation to the inhabitants, but it has led to great adulteration; the salt retailed, being often a mixture of earth and other impurities. Even to purchase this, the people are obliged to live on dry rice, and to forego the use of cinnamon and other condiments."

† The *Board of Customs, Salt and Opium* of the East India Company, estimated the contribution of the rural labourer towards the salt-tax, as equal to one thirty-second part of his yearly earnings, or to a tax of 1½ per cent. on his income; but according to Mr. Crawfurd, they did not consider that a labourer had any family; so that they reckoned every man, woman, and child, as earning the average amount of a labourer's wages; this amount of wages they are said also to have exaggerated. In this calculation, also, the labourer is supposed to be always at work, every day of the year without exception; he is supposed never to be sick, and never to want employment.

The salt, without any reference to its transport, but merely considering the price he would have to pay for it to the first purchaser of the Company's stores, would amount to about 8*s*. a-year for the consumption of a family. The expense of transport would vary according to the distance. It thus becomes too costly an article to be used for other than ordinary culinary purposes. The people have recourse to the ashes of some burnt vegetables to use as a condiment with their food, and there is abundant evidence to show that they use very impure salts, as in the province of Behar and other districts a salt is used obtained from the refuse ley of saltpetre; it contains muriate of soda, sulphate of lime, and sulphate of magnesia. The deficiency of the supply had long been a subject of frequent complaint. In the documentary evidence submitted to the Committee, we find the following extract from a letter from the Governor General's agent in Ramghur:—

"I shall rejoice if your plan for extending the supply of salt to the country in general is carried into effect, because the greater part of the districts under my agency are at times much distressed for want of that necessary article. Singboon, in

particular, is so very precariously situated, that once or twice the Surka-coles have assembled in large bodies round my tent, earnestly beseeching me to apply to Government to adopt some means for their being regularly furnished. The Zemindar of Singboon the other day wrote to me, stating he had not a seer left on his estate, and begging that I would give him a note to the salt agent to enable him to purchase a supply. Salt is only allowed to be transported into Singboon by way of the Bermool Pass. A glance at the sketch of the frontier of those places, will show the hardship of being obliged to bring the salt from such a distance, when it really could be got on the border of their district. Besides the length of the journey, the poor fellows are obliged to pay a toll to every chief through whose district it passes, and there are at least half a dozen of them; the consequence is that salt is smuggled whenever an opportunity offers."

The following was written by Mr. Colebrook in 1794. He says:—"Salt is eagerly desired by the Indian: his vegetable diet requires it, but the most numerous classes cannot afford to season their food with it. Observe the peasant's meal;

a pinch of salt on a leaf stands by his plate of rice, a few grains at a time deceive his palate, while he swallows several mouthfuls of insipid food. His abstemiousness in respect to this and other condiments for which his predilection is known, is not voluntary. He is sensible that he is ill-fed."

At the time when this was written, the price of salt at the public sales was 4*s.* a bushel. In 1831, it was above 5*s.* 6*d.*

In a supplementary document submitted to the Committee, Mr. Crawfurd gives it as his opinion, that there is no considerable country in the world in which salt is absolutely so dear as in Bengal, comparing the actual price of the article with the means of the people to pay. "There are obvious causes for this. There is no part of the coast of Bengal fit to produce salt by the cheap process of solar evaporation. The brine is nowhere strong, because the sea on the coast of Bengal is mixed with an unusual quantity of fresh water. Fuel is comparatively dear, and dearest where the manufacture might otherwise be conducted most cheaply. The process of manufacture is extremely rude, and for centuries appears to have sustained

no improvement whatever. Even after the salt is manufactured, its preservation is precarious, owing to the frequent occurrence of heavy rains, tempests, and sudden inundations. The interior of the country affords no rock-salt and no salt-springs, such as are to be found in almost every other country of considerable extent. The monopoly comes in, in aggravation of these natural causes of high price; conjoined with them, the effect has been an aggravation of cost, which has no other limit than the protection which the smuggler affords the consumer. One example will show the Committee satisfactorily the extent to which the causes now enumerated contribute in enhancing the price of salt; it is this, that a cost of four rupees per maund, which may be considered as an average of recent years' public sales, is equal to a tax in England, on the average prime cost of English salt at 15*s.* per ton, of between 1,300 and 1,400 per cent.; and that a wholesale price of five rupees per maund upon the spot, and without reference to distribution over an immense tract of country, often without roads or bridges, for the most part with indifferent ones, and notoriously deficient in capital, is equal to an

advance upon the same English salt of between 1,600 and 1,700 per cent. It must be clear indeed, that in many parts of the country the cost of salt must be higher than it was even in England when it paid a tax of 15*s.* per bushel, or an *ad valorem* duty of 4,000 per cent. In 1823, for example, in many parts of the country, the price rose to 12 rupees a maund for adulterated salt, which is equal to 32*l.* per ton, or more than the whole price of salt in England before the abolition of the duty. The Committee will be pleased to recollect, that the charges now stated are applicable to a people among whom the wages of labour are at the utmost but one-tenth part of what they are in England."

According to the same authority, the smuggling of salt in India is carried on to an enormous extent. In the western provinces of the Bengal presidency, with a population of upwards of 30,000,000, the whole amount of duty is, according to Mr. Trevelyan, but 160,000*l.* The cause of this is that two-thirds of the whole salt is smuggled, chiefly in consequence of the enormous amount of the duty, which is three times as great as the prime cost of salt in the native states along our

whole line of frontier. Every one gives encouragement and ready assistance to the smugglers of salt; the head-men of villages are most courteous in affording them protection; and all classes combine to defraud the government of its revenues, in order to obtain this requisite of life at the cheapest rate. The native custom-house officers are also said to be bribed and corrupted, while the practical result is, that frequently salt sells in the villages for half the amount which it ought to pay as duty.

Applications had been made from time to time by the salt manufacturers of Cheshire to the East India Company, to be allowed to import salt into Bengal; a most desirable privilege, since a large number of our merchant ships go out to India for cargoes, laden with ballast merely; while to many other parts of the world ships ballast with salt. It was stated before the Committee, that nearly 200,000 tons of salt are annually exported from England, as dead weight or ballast. The proposal was acceded to by the Company, but under such regulations as amounted to a prohibition. It appears from the evidence of Mr. Alexander Reid, that on the arrival of a cargo at Calcutta, the importer was allowed to lodge his salt in the

Government golah, subject to a duty of 3 rupees per maund. A certain time was allowed to the importers to find a purchaser, and if during that time the salt was not sold, the officers of the Government were empowered to dispose of it for the duty. If it did not realize the duty, the salt was destroyed in the presence of the Government officers. The chief difficulties under which the importer laboured, were in the nature of the monopoly, the principle of which was to raise the greatest possible revenue, and this was best accomplished by limiting the supply. The public sales took place periodically, and the purchasers made their biddings under the assurance of Government, that only a stated quantity would be sold during the year. The effect of this was to create a sub-monopoly amongst the dealers, whose interests would be affected by importation, and to check this, the sub-monopoly might so manage as to render it very doubtful whether the importer might not incur the penalty under the regulation, and have his salt destroyed.

The same witness states that the Indian authorities calculate that six seers (about 12lbs.) are consumed by each inhabitant. In England we

reckon 25 lbs. for each. The governor of the workhouse at Liverpool states that the consumption of each person in the workhouse in 1816 (many of the inmates being children), during the period of the high duty, was 11 lbs. 8 oz. each, and in 1835, when there was no duty, it was 16 lbs. 2 oz.; and these quantities did not include any salt used in curing salt-fish, of which a great deal was used, nor the salt used in making bread.

Mr. Worthington, a Cheshire salt-manufacturer, stated that the Cheshire manufacturers can imitate the salt of any other nation, so that if a sample were sent to Cheshire from India as that which most suited the habits of the people, exactly the same description of salt in grain and colour would be sent out.

The Committee made particular inquiries whether any animal substance was used by the Cheshire manufacturers in refining their salt, for if such were the case, the article would be regarded as impure by the Hindoos, and they would not use it. Mr. Tucker, one of the Company's officers, says in his evidence:—"The mere handling of salt by Europeans does not contaminate it. The general maxim of the Hindoo is, that everything

comes pure from the shop if the article be pure in its own nature. Blood or eggs used in refining would contaminate any article of food to a Hindoo. The égg is the germ of life and an animal substance; blood may be that of an animal which they venerate, or of one which would defile."

T. L. Peacock, Esq. assistant examiner of India correspondence at the East India House, stated that the Company's salt is tolerably pure and most suited to the tastes of the natives. It is not perfectly white; the salt in Madras is frequently almost black, from the quantity of earth that is taken up with it from the salt pans. The Bengal salt is grey, from the imperfect system of refining. The people of India do not prefer dirty salt to clean, but they prefer the flavour of the Company's salt; they prefer something in the salt itself, and they can refine it themselves, and make it as pure as the Cheshire salt by domestic processes, if they think proper to do so.

In answer to the statement of Mr. Worthington, that the Cheshire manufacturers could make any kind of salt if a specimen were sent to them, Mr. Peacock remarks, that rock-salt boiled with sea-

water is a very different thing from the Cheshire salt: salt from sea-water contains many things that Cheshire salt does not, as sulphate of magnesia, or not to the same degree, as muriate of magnesia. All salt that is considered best for the fisheries and for salting provisions does, in fact, contain those ingredients, though they are commonly said to be septic ingredients.

Mr. Hugh Stark, another of the Company's officers, stated that he considered the vice of the Company's system to be the limitation of the supply.

Sir Francis Doyle, Chairman of the Board of Excise, stated his opinion that the salt monopoly in India might be conveniently exchanged for a system of excise. "Salt is a good subject of taxation. The tax is very easily collected, and is not much exposed to fraud; and being very extensively used, being used by every individual, it of course amounts in the aggregate to a large sum, although the burden to the individual is very light. I should say, confining myself to the fiscal view of the case, it is a fit subject of duty, and it has always been in all countries, from time immemorial, a subject of duty; but it certainly was

a very enormous rate of duty upon the original cost of the article here."

The Report of the Select Committee, dated 2d August, 1836, states that "They are of opinion that the evils usually incident to a government monopoly in a great article of consumption, are not wanting in the working of the salt monopoly in India; and they have not been convinced by any evidence that has been submitted to their consideration, that the same amount of income which has hitherto been derived from the monopoly might not be collected, with equal security to the revenue and great advantage to the consumer and to commerce, under a combined system of customs and excise." They recommend the abolition of public periodical sales, and that the government "do keep their golahs at all times open for the sale of salt, at the cost price, in quantities not less than 100 maunds, the purchaser to pay in addition a fixed duty on removing the salt from the golahs." They further recommend the importation of foreign salt into Calcutta, subject to the same duty as that sold by the Company; that the duty be fixed at the lowest rate consistent with the maintenance of the revenue. The

Committee think, that if these recommendations are properly carried out, they will reduce the monopoly of the Company to one solely of manufacture, and destroy the sub-monopolies which have necessarily accompanied the existing system. The difficulties which have hitherto stood in the way of a fair competition between native and imported salt being thus removed, they hope that a wholesome and important trade from Madras to Ceylon may be encouraged; and that British commerce may be no longer shut out from the advantage of conveying a cheap, good, and bulky article of British produce to a distant portion of the globe. The Committee also state their conviction "that however modified the monopoly may be, the evils of the system can never be totally eradicated but by its extinction;" and they think "that the interests of the consumer and the revenue will ultimately be best secured by a considerable reduction of duty, under a system of free competition."

Since the date of this Report, several commercial reforms have been made by the East India Company, especially with regard to the abolition of transit duties, and the diminution in the price at

which salt is now sold under its monopoly by the servants of the Company. By an act of the Right Honourable the Governor General of India, in council, dated 3d January, 1838, the rate of duty charged on salt imported into any port of the Presidency of Fort William in Bengal, not covered by a pass, was to pay eight annas per maund of eighty tolas per seer, and having paid this duty it was allowed to be exported free. After the 1st September, 1843, a duty of two rupees per maund was to be levied upon all salt imported, and a further duty of one rupee per maund on the transmission thereof to Allahabad. After this date the manufacture of salt throughout the north-west province of Bengal was prohibited except under the express sanction of Government. A fine of 500 rupees or imprisonment for six months and confiscation of the works was the penalty for breaking this law. By an act dated 30th May, 1846, the rates of duty charged on goods imported into Bengal were modified, and among other articles salt imported, either in British or foreign ships, was to pay from three to four rupees per maund.

Since these new regulations have come into operation the discovery has been announced of

a bed of solid rock-salt in Scinde, of excellent quality, twenty miles in length by fifteen in breadth, of an average thickness exceeding three feet. It is calculated that this salt could be delivered at the Company's deposits near Bombay at *5s.* a ton; whereas, the average price paid by the Company in 1847 was *2l.* 4*s.* 8½*d.* Kotree, the place where this great salt-bed is found, is 500 miles from Bombay.

CHAPTER IX.

USES OF SALT TO CATTLE—USES OF SALT IN THE FIELD AND THE GARDEN—INJURIOUS EFFECTS OF SALT—PRECAUTIONS NECESSARY TO ITS USE IN AGRICULTURE—INCONVENIENCES FROM THE USE OF SEA-WATER IN STEAM BOILERS—MANUFACTURE OF SODA FROM COMMON SALT—CONCLUSION.

THE value of salt, as an article of food to man, was noticed in the first chapter. It is also a useful ingredient in the food of horses, sheep, and cattle; for, by promoting digestion it occasions them to make rapid progress in fattening. It has been found that in feeding with chaff or cut straw, a larger quantity of this cheap and ordinary food can be given when sprinkled with salt than without this condiment, and that as the filling the stomachs of cattle while fattening is of great importance, a very large portion of chaff, if seasoned with salt, may be given with advantage to the growth and health of the animals. Every grazier knows that an abundance of very ordinary food, if eaten with relish, will fatten cattle much sooner when given with a small allowance of substantial

provender, than better food alone in a moderate quantity. There is, indeed, hardly any food that can be offered to cattle, which, if mixed with salt, will not be eaten with eagerness. It has been stated, that in feeding cattle 14 lbs. of chaff, such as is produced in winnowing corn, and which of itself is of little or no value, will, when softened by steam and mixed with two ounces of salt, save 42 lbs. of turnips.

It is a common practice with the farmers of the United States of America, in stacking hay, to mix salt with it, in the proportion of about 14 lbs. of salt to one ton of hay, a practice which has of late years been introduced into this country. It is also usual in America to give salt to sheep and cattle, and these animals will follow any one to any distance, who should tempt them by showing them a portion of salt held in the hand. In the Alpine pastures of Switzerland, the shepherds are in the habit of occasionally giving the sheep a small supply of salt; and so eager are they to receive it, that they run up to the shepherd and take it out of his hand: they will even come up to travellers and follow close upon their footsteps, expecting to receive a morsel of their favourite

food. On ascending the pastures above the Mer de Glace, in 1845, the writer was surprised to see the sheep come up to the guides as familiarly as a house dog would do.

It cannot be doubted that salt, when given judiciously to live stock, assists their digestion, preserves them from disease, and improves their condition. It appears also, that the milk and butter produced from those cows which are allowed the use of salt is more abundant, and never acquires that turnip flavour which is common in the milk and butter of cows which are kept upon turnips without salt. Common salt is also a cure for botts in horses, is useful in preventing the rot in sheep, while the wool of such sheep as are fed on salt is materially improved.

Mr. Parkes recommends the following quantities of salt to be given to the live stock upon a farm:—To neat cattle, four ounces of salt per day, mixed up with steamed chaff, or other moistened food; one half to be given in the morning, and the other half in the latter part of the day. To horses, four ounces per day, in two portions. To young heifers, two ounces per day, in two portions. To calves, one ounce per day, in two portions. To sheep, two

ounces per head per week. The salt to be spread very thin upon slates or tiles, in the field where the sheep are fed.

In the jurisdiction of Arles in Provence, is a district named Crau, extending in length about six leagues, and in breadth about three. The whole surface is covered with small rough stones, and not a tree or bush is to be seen in the whole district, except here and there upon the borders. Yet on this spot, apparently so sterile, numerous flocks of sheep are bred and reared; and what is not less remarkable, they are more healthy and hardy, and endure the severity of the winter with less loss, than those fed in more copious pastures with the advantage of better shelter. The wool of these sheep is the finest in the country, and bears the highest price of any in France. These results are obtained by the free use of salt; for it frequently happens, that the Crau is so burnt up in summer, that the poor animals are forced to turn up the stones to come at the few blades of grass that grow round them; and yet none perish for want of food.*

Mr. A. Young states,† that in Spain, where the

* Memoirs of the Royal Academy of Sciences at Paris.

† Annals of Agriculture, vol. xxiv.

celebrated Merino wool is produced, great quantities of salt are given to the sheep, to which is attributed, in great measure, the fineness of the wool. The salt is placed upon the rocks, and the sheep come and lick it, and are exceedingly fond of it. Mr. Young also stated in his evidence before a Parliamentary Committee, on the salt duties, in 1818, his own experience of this subject. He says, "I found the sheep so fond of salt, that I had troughs ten feet long, nine or ten inches wide, and three or four inches deep, in which I scattered salt for them; and feeding them with my own hand, I found them so ravenously fond of it, that the moment they saw me at the gate of the field, they galloped up from every part, and surrounded the troughs so eagerly, that I was forced to place a pole about eighteen inches or two feet long over the troughs, to keep them from jumping in; but all their heads were in the trough in a moment."

Sir John Sinclair also stated before this Committee—"I was once at the farm of a great farmer in the Netherlands, a Mr. Moselman at Chinoi, near Wavre, where I was surprised to see an immense heap of Cheshire rock-salt, which he said he found of the greatest use for his stock; he said, first,

that by allowing his sheep to lick it, the rot was effectually prevented; secondly, that his cattle, to whom he gave lumps of it to lick, were thereby protected from infectious disorders, and the cows being thus rendered more healthy, and being induced to take a greater quantity of liquid, gave more milk; and I saw lumps of this salt to which his cows had access, in the place where they were kept. He also said, that a small quantity was found very beneficial to the horses when new oats were given to them, if the oats were at all moist.

It is an interesting fact that bees during the breeding season are exceedingly fond of salt. Dr. Bevan, an experienced bee-keeper, says:—"I keep a constant supply of salt and water (about a teaspoonful to a pint,) near my apiary, in a shallow dish, covering the bottom with small pebbles, and find it thronged with bees from early noon till late in the evening. About this period the quantity they consume is considerable; but afterwards they seem indifferent to it."

The uses of salt in agriculture are enumerated by Mr. C. W. Johnson in the Farmers' Cyclopædia. The following is an abridged statement. 1. In small proportions salt promotes the decomposition

of animal and vegetable substances, in all cultivated soils; and when properly used enables land which has been deteriorated by one crop to bear another with advantage. 2. It destroys vermin and kills weeds, which are thus converted into manure. 3. It is a direct constituent or food of some plants, and it has been ascertained that if salt be applied to a soil, the vegetables afterwards growing on that land will contain an increased proportion of common salt. All marine plants contain it in considerable proportions. 4. Salt acts on vegetable substances as a stimulant. Dr. Priestley added to phials containing an ounce and a half of water, various proportions of common salt, from one to twelve grains, and in the solutions placed various sprigs of mint and other vegetables. In those solutions which contained more than twelve grains, the plants died immediately, and the rest died in their order, except that which contained three grains of salt, which seemed to grow as well as plants growing in simple water. It was remarkable, however, that this plant, as well as all those that died in the stronger solutions, seemed to flourish at first more than those which were growing in simple water, and that that which had three grains of salt,

and that which had one grain only, continued to live after the plants in simple water were dead. 5. Salt preserves vegetables from injury by sudden transitions in the temperature of the atmosphere. Thus salted soils do not freeze so readily as those without salt; salt preserves crops of turnips, &c. from injury by the frost. 6. Salt renders earth more capable of absorbing the moisture of the atmosphere; a property of great importance, since those soils which absorb moisture freely from the atmosphere are always most valuable to the cultivator. The pan scale of the salt makers is well adapted as a manure for the grasses, such as clover, lucern, sainfoin, &c. Salt is useful for wheat, although it rarely causes the plant to grow larger or taller, but it causes the ear to fill better, and brings the weaker plants forward. The salt should be applied some time before sowing the seed, not less than ten and not more than twenty bushels per acre. Mr. Challis, of Panfield in Essex, speaks of the beneficial results of manuring with salt. He says:—"The soil that I described to you to be of rather a loose hollow description, had a dressing of salt in November, after the wheat was sown, about fourteen or fifteen bushels per

acre; it produced at the rate of six bushels per acre more than that which was not dressed, and it may be stated to be 1*l.* per load of forty bushels better in quality."

A solution of salt is useful as a steep for the seed-corn, to prevent the smut in wheat. It is also said to be a preventative of mildew in grasses. The Rev. E. Cartwright says, that when salt water is sprinkled with a brush upon diseased plants, it effects a complete cure. The proportion, one pound of salt to a gallon of water, laid on with a plasterer's brush, the operator making his casts as when sowing corn, is instant death to the fungus.

As a manure for grass land, meadows, &c. salt has been tried in all parts of England with varying success. It always sweetens the herbage. It has been employed at the rate of six to sixteen bushels per acre, and where the first object has been the destruction of old turf, double this quantity has been used.

Mr. Collyns, of Kenton in Devonshire, writing in 1826, says:—"One of my neighbours informs me, that in using salt as a manure on grass land, he found the salted portions not to be affected by severe frosty nights, when every blade of grass on

the unsalted portions has been in a frozen state. He found too that salt is destructive to every kind of grub and worm, and he is convinced that where it has been used with judgment, it has not failed. Another intelligent neighbour, whose farm is almost entirely a light black sand, writes—'I have found salt answer my most sanguine expectations for barley, oats, potatoes, and turnips, both as to the increased quantity and improved quality of the crops, of which I can now give proof;—my barley and oats, which used to yield me only fifteen to twenty bushels per acre, now yield from forty to forty-five. My wheat is certainly much improved in quality, but I expected more in quantity. I have had thirty-five bushels of wheat, from an acre dressed with ten bushels of salt; and from the same field last year, after the same quantity of salt, 140 bags of potatoes per acre. This year again, dressed with ten bushels of salt, I have not more than twenty bushels of wheat per acre, but the quality very superior indeed, and the root of clover in it, very fine and luxuriant. In every field I have salted, I find the grass very much superior to any produced before the use of salt.' I have since," adds Mr. Collyns, "gone over his farm, and am

astonished at the verdant pasturage in what used to be coarse and rushy meadows. In this arable land he never got more than ten bushels of wheat per acre, until he used salt: so that this is also a decided improvement."

In using salt for the destruction of vermin, from five to ten bushels per acre are sufficient without danger to the crops. The effect is direct and the result immediately apparent. To kill weeds, and cleanse fallows, salt has been used at the rate of from twenty to forty bushels per acre. The effect for a time is to destroy all vegetation, but in a short period a much superior turf is produced. If the weeds, parings of turf, ditches, banks, &c. are collected, and half a bushel of salt to every ton of the collection be spread evenly over it, every weed will be killed in a few weeks; and this salted manure can be used with great advantage as a dressing for turnips and oats.

Salt has been employed by the gardener to prevent worm-casts on lawns, and on gravel walks to kill weeds; it may also be employed as a fertilizer in gardens with decided advantage. Florists might also use it with good effect. A very small quantity of salt added to the water in which

flowers are placed adds considerably to their duration. There are many bulbous-rooted flowers which flourish best in the immediate vicinity of the sea. It is a common custom with the importers of exotic plants to dip cuttings in salt water. Mr. Hogg, the florist, says:—"I am satisfied that no hyacinths will grow well at a distance from the sea, without salt. I am also of opinion that the numerous bulbous tribes of amaryllidaceæ, especially those from the Cape of Good Hope, ixias, alliums, which include onions, garlic, shallots, &c., anemones, various species of the lily, antholyza, colchicum, crinum, cyclamens, narcissus, iris, gladiolus, ranunculus, scilla, and many others, should either have salt or sea-sand in the mould used for them. I invariably use salt as an ingredient in my compost for carnations—a plant which, like wheat, requires substantial soil, and all the strength and heat of the summer to bring it to perfection; and I believe I might say, without boasting, that few excel me in blooming that flower."

Such are some of the advantages of salt in the field and the garden. Should circumstances arise to occasion an excess of that mineral in a soil, the result may be fatal to the plants upon it. In the

inundations of the sea at Friesland in 1825, various effects were produced by the salt water. The oak, the mulberry, pear, peach, and others with deep roots, did not suffer; neither did the asparagus, onions, celery, &c.; but the vines and gooseberries contracted a salt taste; and the apricots, apples, cherries, elms, poplars, buck, willows, &c., could not bear the over dose of sea-water. They pushed out a few leaves, but speedily perished. Similar results were noticed after an inundation of the sea in the garden of Mr. Gower, near Ipswich, in November, 1824. A portion of the garden remained twenty-four hours covered with sea-water. The asparagus beds were materially improved in their produce. The cherry trees in the following year produced a numerous crop of cherries, but they tasted so very salt, that they could not be eaten, although very fine in appearance. These trees all died in the following year, 1826.

In a communication to the British Association in 1848, Mr. Randall gave some details respecting the poisonous effect of a solution of salt on plants. In September, 1847, three or four small plants in pots, nearly or quite dead, were shown to Mr.

Randall, and he was informed that their destruction was a complete mystery to the party to whom they belonged, and that Dr. Lindley had expressed his opinion, from the examination of a portion of one sent to him, that they were poisoned. Having searched in vain for any strong poison in the soil, and in the plants themselves, he inquired more minutely into the circumstances of the case, and found that these were only specimens of many hundreds of plants, both in the open air and in greenhouses, (but all in pots,) which exhibited in a greater or less degree the same characteristics. The roots were completely rotten, so as to be easily crumbled between the fingers; the stems, even in young plants, assumed the appearance of old wood; the leaves became brown, first at the point, then round the edge, and afterwards all over, while the whole plant drooped and died. At least two thousand cuttings in various stages of progress, and a thousand strong healthy plants, had been reduced to this condition, including different varieties of the fir, cedar, geranium, fuchsia, rose, jasmin, and heath. The sight of this wholesale destruction, coupled with the fact that all the plants were watered

daily from one particular source, suggested the conclusion that the cause of the evil might be found in the water thus used; and this was accordingly examined. In each imperial pint of twenty fluid ounces nearly nine and a half grains of solid saline matter were found, of which nearly seven grains was common salt, the remainder being carbonate of lime, sulphate of lime, chloride of calcium, and chloride of magnesium. The mould around the plants and an infusion of the dead stems and leaves also showed the presence of much common salt. Further inquiry showed that the well from which the water was procured had an accidental communication, by means of a drain, with the sea, and had thus become mixed with the salt water from that source, and had been used in this state for some weeks, probably from two to three months. From about that time the plants had been observed to droop, but it was not until nearly the whole of a valuable stock had been destroyed that the cause of the evil was suspected. To place it beyond doubt that the water was really the cause of the mischief, twelve healthy fuchsias were procured from a distance and divided into two parts, half being watered morning and even-

ing with the water in question, and the others with rain water. In a week the six plants watered from the well had turned brown and ultimately died, while all the rest remained perfectly flourishing. Hence it appears that the continued use of water containing about seven grains of salt in each pint, is an effectual poison to the weaker forms of vegetation; or that when a soil is continually watered with a weak solution of salt, it gradually accumulates in it, until the soil becomes sufficiently contaminated to be unfit to support vegetable life. Mr. Randall suggests, as an interesting subject of inquiry, What is the weakest solution of salt which can produce this poisonous effect? or, in other words, at what degree of dilution does the danger cease? For salt is an important natural constituent of much spring water; quite independent of any infiltration from the sea, as in this instance. Thus, the water of the artesian well, Trafalgar Square, London, contains in

each gallon about	20	grains.
That at Combe and Delafield's Brewery	12·7	,,
That at Wolverton Railway Station	6	,,

One lately sunk at Southampton for supplying a private manufactory . . . . 40 grains.

Professor Johnston, in his Lectures on Agriculture, states that the use of salt as a manure has in many cases been over-estimated. Sanguine men have made large trials of this mineral on their land, which have occasionally ended in disappointment, and hence the use of salt has repeatedly fallen into undeserved neglect. Now, as the cases where common salt has been used with great advantage are met by other cases where its use has failed, it becomes important to understand the principle upon which it can be applied to one soil and not to another, and in one locality and not in another.

In the first place, it is known that plants require for their sustenance and growth a certain supply of each of the constituents of common salt, which must be commonly obtained from the soil. If the soil contain already a sufficient supply of salt, or of chlorine and soda in any other form, it will not be necessary to add salt to the soil: and if added, it will produce no beneficial result. If, on the contrary, the soil be deficient in salt, its addition

may cause a considerable increase of the crop. Now, there are certain localities in which salt is likely to be abundant in the soil; such as the lands situated near the sea-coast, or those exposed to the action of prevailing sea winds, which carry the spray of the sea, and deposit it in rain over the land. Hence the use of salt is likely to be beneficial in spots remote from the sea, or sheltered from prevailing sea winds. Indeed, in the recorded accounts of extensive experiments on the use of salt as a manure, it has been found to succeed in localities more or less remote from the sea, while most of the failures were on lands near the coast.

In the second place, some plants are more likely to derive benefit form salt than others. Certain species flourish by the sea shore, and where they grow inland they select such soils as naturally contain much saline matter. The grass of salt marshes is peculiarly nourishing, and is much relished by cattle. The grass lands along various parts of our coast are also highly favourable to cattle. The long tussack grass of the Falkland Islands is said to be most luxuriant where it is within reach of the driving spray of the southern

sea. So among our cultivated crops, one may require more salt than another ; and if we consider how much alkaline matter is contained in the tops and bulbs of the turnip and the potato, we may conclude that salt will benefit green crops more than crops of corn, and will tend to develop the leaf and stem, rather than to fill the ear. Hence, a soil may contain sufficient salt for the wants of one crop and not enough for another; and the application of salt may prove a failure or otherwise, according to the kind of crop intended to be raised.

Thirdly; favourable results may have been obtained from the first application of salt to land, and not from a second. By the first process the land was probably supplied with sufficient salt for some years' consumption, and requires the application of some other substance.

The circumstances necessary to ensure the success of saline manures are thus enumerated by Professor Johnston:—

1. They must contain one or more substances which are necessary to the growth of the plant.

2. The soil must be more or less deficient in these substances.

3. The weather must prove so moist, or the soil be so springy as to admit of their being dissolved, and conveyed to the roots.

4. They must not be applied in too large a quantity, or allowed to come in contact with the young shoots in too concentrated a form; that is, the water that reaches the roots or young leaves must never be too strongly impregnated with the salt, or if the weather be dry the plant will be blighted or burned up.

5. The soil must be sufficiently light to permit the salt easily to penetrate to the roots, and yet not so open as to allow it to be readily washed away by the rains. In reference to this point, the nature of the subsoil is of much importance. A retentive subsoil will prevent the total escape of that which readily passes through a sandy or gravelly soil, while an open subsoil will retain nothing that has once made its way through the surface.

Among the inconveniences arising from the presence of salt, is the use of salt-water for raising steam in the boilers of marine engines. The boiler boils over or *primes*, as the engineers call it, and part of the water is forced up so violently

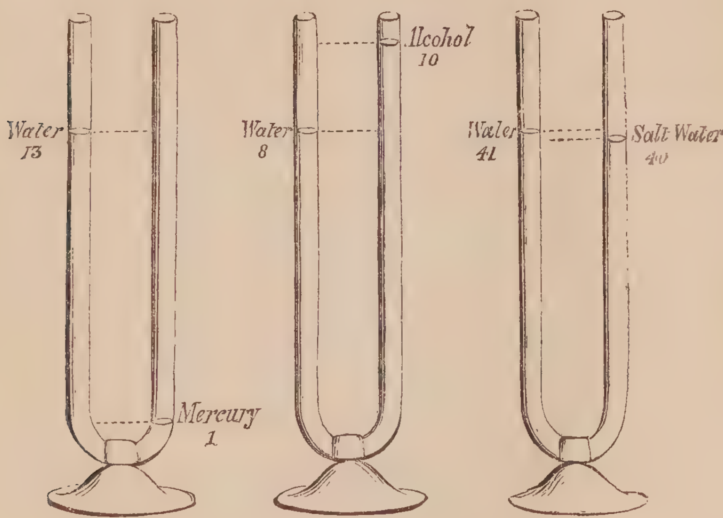
as to pass over into the cylinder of the engine; a circumstance which is always injurious and sometimes ruinous to the engines. This arises from the thickening of the water, the saline contents of the sea water remaining behind and accumulating in the boiler, while the fresh portion of the water is passing off in the shape of steam. This process of accumulation of solid matter in the marine boiler is by no means slow. The whole of the water which a marine boiler usually contains is evaporated in three or four hours, leaving the solid substances behind; and being replaced by salt-water containing an equal quantity of solid matter, which in its turn is also left behind. Now, as the solid matter amounts to as much as one-fortieth of the whole mass of water, it would follow that if the process of boiling were to continue so long as 150 hours, there would be deposited in the boiler a quantity of solid matter equal to the number of tons of water in the whole content of the boiler. But long before this degree of solidification can take place, the boiler is rendered useless. The saline matters of the salt water which are left behind do not diffuse themselves through the whole of the liquid so as to form a uniform brine,

but as the new supplies of the sea water enter the boiler they float at the upper part while the denser brine forms a bed in the lower part of the boiler, and surrounds the fire-box and heating-flues. The intense heat of the metal expels the water from the brine in contact with it most rapidly in the hottest places, and salt is deposited on the hottest parts of the furnaces and flues, extending rapidly to those less heated, and so not only interfering with the power of the boiler to produce steam, but injuring its substance and endangering its existence. The common remedy for this inconvenience is called "blowing down" or "blowing off," and is performed in the following way. There is forced into the boiler at each stroke, rather more water than is required for the supply of steam, so that the boiler becomes too full. Openings are then suddenly made at the bottom of the boiler, and the brine at the bottom being violently ejected, carries with it any solid substances that may have accumulated near the bottom, and the boiler is thus cleansed. Before the water has got too low the openings are again closed, and the boiler continues to be fed as formerly.

Another remedy introduced by Messrs. Maudsley & Field, is the brine pump, by which, for every portion of water supplied to the boiler, about one-fourth part of the quantity of brine is withdrawn from it. This process does not so thoroughly carry off all the impurities as the former; but it is attended with a saving of fuel, by a contrivance for giving to the feed-water entering the boiler a portion of the heat of the discharged brine.

In whatever way the saturation of the water with solid matter may be remedied, it is important to be able to ascertain easily when the cleansing process is required, and whether it has been applied with success. Several contrivances have been invented; but, perhaps, the most convenient is that by Mr. Scott Russell. It is founded upon the law, that the heights of columns of liquids which balance each other vary inversely as the densities of those liquids. For example:—if we take open glass tubes bent in the form of the letter U, and pour one fluid into one of the sides, and another fluid into the opposite side, (taking care to pour the heavier liquid first,) the one being mercury and the other water, they will stand at

the height of one inch and thirteen inches respectively. If we use alcohol and water (fig. 2), they will stand at the height of ten inches and eight inches respectively, the height of the one



1 2 3

fluid being always greater than that of the other in the proportion in which its weight, density or specific gravity, is less. In like manner fresh water and salt water (fig. 3,) will stand at heights of forty and forty-one inches, showing a difference of one inch.

The use which Mr. Russell makes of this principle is as follows:—

"I reckon the best scale of saltness of a boiler to be that which takes the common sea water as a standard. Sea water contains $\frac{1}{40}$th of saline matter. When the water has been evaporated so as to leave only half the quantity of distilled water to the same quantity of saline matter, I call that two degrees of salt, or brine of the strength of two, and such brine would show in fig. 3 the columns forty and forty-two, or double the saltness of sea water, indicated by a difference of two inches. A further saturation would be indicated by a difference of three, four, five and six inches between the columns, and so indicate three, four, five, six and any further degrees of saltness,—a range which may be made to any degree of minuteness by the subdivision of the scale of inches."

The mechanical apparatus employed to give this indication is perfectly simple. To the marine boiler are applied two water gauges of glass, instead of one, as at present used. To these gauges are attached small copper pipes, so that one of them may be placed in communication only with the salt brine in the lower part of the boiler, and the other with the feed-water which is entering the boiler; the one then holds a column of brine

and the other of pure sea water, and each inch of difference shows the degree of saturation.

As a practical rule Mr. Russell finds it necessary to blow off when the brine at the bottom has about three degrees of saltness. The operation of blowing off must be continued until if possible the difference in the height of the columns is less than an inch, and it will not be necessary to blow off again until the difference is at least six inches.*

In addition to the numerous uses of salt for culinary purposes, for mingling with the food of cattle, for manuring land, &c., there is an enormous demand for it for the purposes of the chemical manufacturer; this being the source of nearly all the soda and its compounds in common use, and also of the chlorine used in making bleaching powder, &c. During the long period when the high duty of 15*s.* per bushel on common salt existed, its use was limited, as its name *table-salt* implied, almost entirely to the purposes of food. The soda used in soap making and for other purposes was obtained by burning marine plants, such as the *Salsola soda* and *Salicornia*

* From a paper read before the Royal Scottish Society of Arts, 28th February, 1842.

herbacea on the shores of the Mediterranean and other warm climates; the ash thus obtained was named *barilla:* while on the coasts of Ireland, and the western coasts and islands of Scotland, an inferior article, named *kelp*, was procured by burning the *Fucus vesiculosus* and other species of fuci. The repeal of the duty on salt almost entirely superseded the manufacture of kelp, the supply of soda being now furnished chiefly by the decomposition of common salt by a process invented by a French chemist, named Leblanc, at the close of the last century. Previous to the Revolution of 1789, the soda used in France was obtained from marine plants as above described, chiefly from the coast of Spain. The wars in which France was engaged with nearly all Europe, put a stop to this and other branches of native industry. The importation of potash was also stopped, and all the supplies of that substance that could be obtained in France were devoted to the manufacture of gunpowder. The manufacturers of glass, soap, &c. were thus deprived of an article essential to their very existence. In this emergency the Committee of Public Safety called upon all citizens to place in the hands of

commissioners, without any regard to private interests, any plans for the preparation of soda that might be known. The commissioners reported, that among the numerous plans submitted to them, that by Leblanc was most practicable, and best adapted to the wholesale dealings of the manufacturer. This plan was adopted, and the first establishment for carrying it out was erected at St. Denis in 1804. After the repeal of the salt duty, the process was introduced into this country, and altogether it has been in use for nearly half a century with little or no alteration in its most important details.

Bearing in mind the chemical composition of chloride of sodium, or common salt, (its two constituents being united in the proportion of thirty-five parts by weight of chlorine to twenty-three of the metal sodium,) the following details respecting the manufacture of soda will become intelligible. The first part of the process consists in converting common salt into sulphate of soda. This is done in reverberatory or *decomposing furnaces*, as they are called, a number of which are arranged side by side, all discharging their flues into a tall chimney, which is the most conspicuous object on

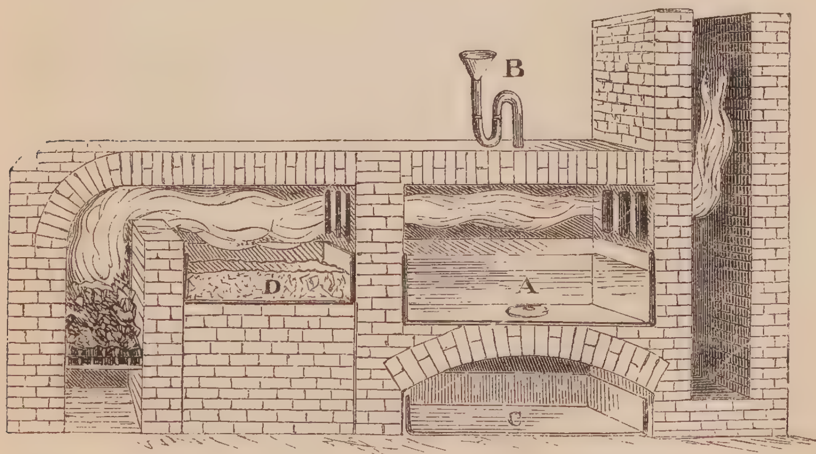
approaching the alkali works from a distance. The floor, or sole of each furnace is of brick, but is sometimes lined with lead, and is usually divided into two compartments, in one of which the liquid portion of the mixture is evaporated, and in the other the residuary sulphate is calcined. In some furnaces the evaporation and calcination are carried on in the same division. The figure at p. 351 represents a furnace of the former kind. In the division A, farthest from the fire, called the *decomposing bed*, the salt and sulphuric acid are brought together. The quantity of salt introduced at one charge varies, according to the size of the furnace, from two or three cwt. to half a ton. A nearly equivalent weight of sulphuric acid is poured very slowly on the salt through an opening in the roof, closed at other times with a leaden plug, or through a leaden syphon funnel B, as in the figure. The quantity of acid is so adjusted that the salt may be in excess, which is far more desirable than an excess of acid. The mixture is equalized by stirring with an iron rake covered with sheet lead. Abundant fumes of hydrochloric acid result from the decomposition, which are conveyed through the flue into the chimney, and

discharged into the air, or they are condensed into liquid hydrochloric acid; but as the consumption of this acid bears only a small proportion to that of soda, it is generally more profitable for the manufacturer to allow the acid fumes to escape into the air, where, on emerging from the top of the chimney, they form a white cloud of acid, which rains sterility and desolation on the surrounding country. Many alkali works have been indicted as nuisances on this account. Attempts were made to remedy the evil by discharging the fumes higher in the air, where it was supposed that the great dilution, by combining with atmospheric vapour during their descent, would render them comparatively harmless. This is the origin of those wonderful chimneys, such as that of Muspratt, 495 feet high, and 30½ feet in its lower and 11 feet in its upper diameter, and containing a million of bricks in its structure,—while the chimney of Tennant's soda works at St. Rollox near Glasgow is of still larger dimensions. These costly structures have not been found to answer the purpose for which they were intended, so that it has been necessary to condense the gas as fast as it is discharged from the mixture of salt and

sulphuric acid.* But to return to the decomposing furnace. In about two hours the fumes cease to be copious, and the residuary sulphate of soda becomes a pasty mass. This is now pushed out of the decomposing bed through an opening at the back of a furnace into a kind of vault C, furnished with a chimney, by which means the workmen are not exposed to the suffocating acid fumes. Another charge is then immediately introduced, and the decomposition goes on as before. The product of the first charge having cooled

* Patents have been taken out at various times for contrivances for condensing the acid fumes, and converting them to some useful purpose. In one contrivance, the chimney is filled with rounded flints, and in another with coke, kept constantly wet by a small stream of water from the top; and the acid thus condensed by exposure to an extensive humid surface is conveyed along a pipe at the bottom of the chimney, into a subterranean reservoir. In another arrangement, the condenser consists of a series of upright channels or flues, in which the fumes alternately ascend and descend: water falls into these channels from above, and is distributed over boards placed obliquely. Or by another contrivance water is admitted at the bottom of the condenser in the form of a fountain. In some works the acid fumes from the salt, instead of being condensed, are advantageously employed in the manufacture of bleaching powder (chloride of lime); in other works the condensed acid is employed to generate carbonic acid from limestone, for the manufacture of bicarbonate of soda, or of carbonate of magnesia.

down, so as not to produce acid fumes, is next shovelled into the other compartment of the furnace nearest the fire, called the *roasting bed* D, where it is exposed to a greatly increased temperature, which in an hour or two dissipates all the remaining muriatic acid. During this operation it changes from yellowish to white. It is now called *salt cake*, and is raked out to make room for another charge.

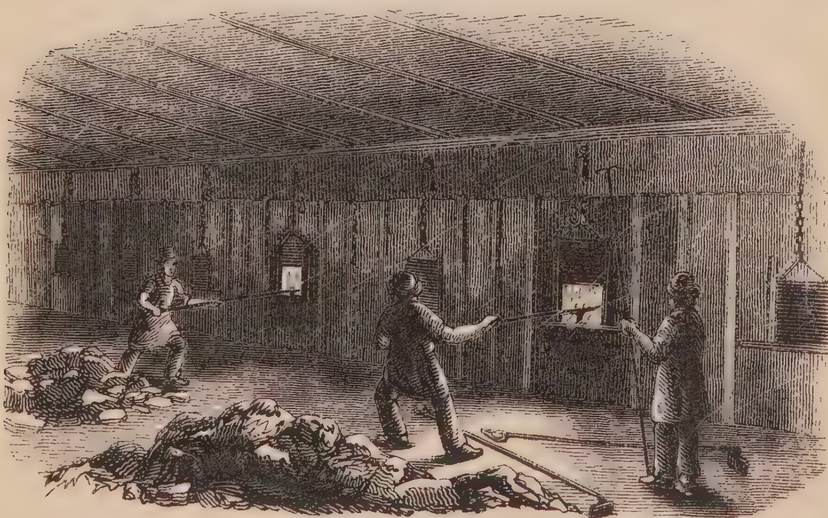


The object of the next process, which is the most important in the manufacture of soda, is to convert the salt cake or sulphate of soda into carbonate of soda, which is done by heating it to redness, with charcoal and carbonate of lime. By

the original method, 100 lbs. of salt cake were mixed with the same weight of chalk and 55 lbs. of charcoal, all ground to a coarse powder, and well mixed by sifting. But as in this country wood-charcoal is too expensive to be used for the purpose, small coal is substituted, and the carbonate of lime may be either in the form of limestone, or chalk. The charge, amounting to 2 or 2½ cwt., is heated in a reverberatory furnace, called the *black-ash furnace*; this is oval in shape, and about 10 feet long in the sole, all corners being avoided, in order that no portion of the charge may escape the action of the fire and the stirring rods. The sole is divided into two parts, one of which, the farthest from the fire, is higher than the other part. The first division is the *preparing bed*, in which the charge is first heated, to avoid cooling the furnace. The second division, called the *fluxing bed*, is slightly concave.

The proportions of the salt cake, coal, and carbonate of lime, as well as the weight of the charge, vary at different works. The charge is shovelled in upon the preparing bed, and spread evenly; when sufficiently heated, it is transferred, by means of an iron tool shaped like an oar, to the fluxing

bed, which should be at a full red heat. As soon as the mixture is ignited and begins to clot on the surface, it is turned cautiously over by the oar or spreader, so as constantly to expose a fresh surface to the fluxing action of the fire; care being taken not to raise the lighter portions into a dust, or they would be carried away by the draught of the furnace, and wasted. When the whole mass has



a doughy consistence, chemical decomposition begins; jets of sulphuretted hydrogen and carbonic oxide, called *candles* by the workmen, escape from various parts of the mass, which is now sedulously worked about with the spreader and an iron rake.

At length the mass of soda melts, and, from the rapid escape of gas, appears to boil. At length it settles down, and when all the "candles" have disappeared, the mass is raked out into cast-iron troughs or iron wheelbarrows, where it becomes solid, and forms a mixture of what is called black-ash, with *ball-soda* or *British barilla*. A second charge is then shifted from the preparing to the fluxing bed, and a third charge immediately placed on the preparing bed. In some large works a ton of the mixture is thus worked off in six hours.

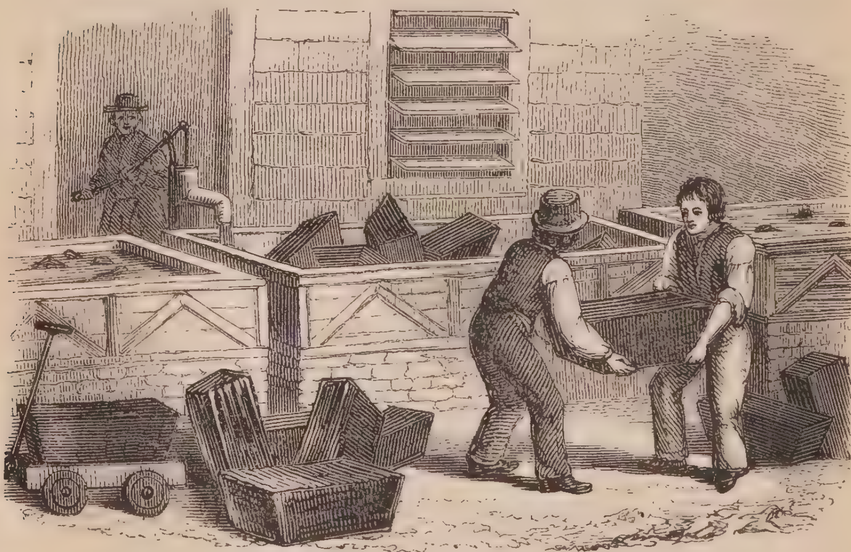
The chemical changes which take place in the above process are somewhat complex, but the most important may be stated thus:—The sulphate of soda, by calcination with the coal, loses its oxygen, and becomes converted into sulphuret of sodium; the carbonate of lime and the sulphuret of sodium then act upon each other, the oxygen of the lime converting the sodium into soda, and the carbonic acid of the lime uniting therewith to form carbonate of soda, while the sulphur of the sodium unites with the calcium of the lime* to form sulphuret of calcium. This last-named substance, called *soda waste,* is a source of great annoyance to

* Lime is an oxide of the metal calcium.

the manufacturer; it is bulky, and applicable to no useful purpose yet known. Vast heaps of it accumulate in the neighbourhood of alkali works, often making it necessary to purchase land merely to accommodate it. Attempts have been made to recover the sulphur from it, but hitherto the cost has exceeded the value of the sulphur regained.

The next process is to separate the soluble matters from the black ash. A ball of about 3 cwt. as it leaves the black ash furnace, affords an average of $1\frac{1}{4}$ cwt. of soda ash. The insoluble ingredients consist of carbonaceous matters, carbonate of lime, and a compound of lime and sulphuret of calcium. The soluble ingredients are carbonate of soda, a little undecomposed sulphate of soda and common salt, some caustic soda, and a few other ingredients. The separation of these matters is the first step towards the preparation of pure soda from black ash, and this is effected by reducing the mass to fragments, either by crushing it under mill-stones, or by exposing it to the vapour of water, which causes it to swell up and fall to pieces. The fragments are put into iron vats, and covered with warm water. In ten or twelve hours the solution is drawn off, and the

residue washed six or eight times successively, either with fresh water or with the washings of other vats. The lye thus obtained is evaporated to dryness in leaden pans, by which a carbonate



BLACK-ASH VATS.

of soda is obtained, mixed with a little caustic soda and sulphuret of sodium. This is further purified by mixing it with about one-fourth of its weight of sawdust or coaldust, in a reverberating furnace, when the sulphuret of sodium parts with its sulphur and becomes converted into carbonate of soda. In some cases the sawdust or coal is omitted, and the

calcination carried on in what is called the *white-ash furnace.* When the liquid assumes the consistence of mortar it is raked into a large iron vessel, with a false perforated bottom, to allow the mother liquor to drain off from the crystals. The drained mass is then put into a finishing furnace, and moderately calcined, being worked about in all directions, so as to bring every part within the flame and in contact with air. The residue of this operation when ground under mill-stones is the *white ash* or *soda ash* of commerce, and is sufficiently pure for most of the manufacturing applications of soda; but for the manufacture of plate glass, and for furnishing crystals of carbonate of soda, the ash is rendered still purer by another calcination at a moderate heat. For the crystalline carbonate, the purified ash is dissolved in hot water to saturation, and the solution run into large cast-iron pans. The soda separates in large well-formed crystals, which are broken up, and the mother liquor allowed to drain off. These crystals are carbonate of soda, nearly pure: 100 parts contain 21.81 soda, 15.43 carbonic acid, and 62.76 water; when exposed to air they fall to powder; boiling water dissolves more than an equal weight

of them. The mother liquor which drains off contains nearly the whole of the foreign salts, and is evaporated to dryness: the residue generally contains about 30 per cent. of alkali, and serves the purposes of the crown glass and soap manufacturer.

In conclusion, the writer would remark, that as this is probably the first attempt to bring together the various details respecting common salt, so as to form a natural history of that mineral, he may have omitted some particulars respecting it scattered through works to which he has not found references. Enough however has been stated to show that the wonderful variety of the works of God is as conspicuous in the history of this single member of the mineral kingdom, as in any other subject apparently more complex.

C. T.

THE END.

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